

DESIGN OF EXPERIMENTS

ME-8101

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Introduction

The role of experimental design, basic principles, use of statistical techniques in experimentation

Simple Comparative experiments

Introduction, basic statistical concepts, sampling and sampling distributions, inferences about the differences in means, randomized designs, related problems

The analysis of variance

Introduction, the one- way classification of ANOVA, analysis of the fixed effect model, comparison of individual treatments means, the random effects model, model adequacy checking, choices of sample size, fitting response curves in the one way model, the regression approach to ANOVA, related problems

Randomized blocks, Latin squares and related designs

The randomized complete block design -statistical analysis, model adequacy checking, estimating missing values, estimating model parameters, The Latin square design, related problems

Incomplete block design

Introduction, balanced incomplete design, partially balanced incomplete designs

Factorial designs

Introduction, basic definitions & principles, advantage of factorials, the two factor factorial design, random and mixed models, the general factorial design, fitting response curves and surfaces, dealing with unbalanced data, related problems

2^k and 3^k factorial designs

Introduction, analysis of the 2^k factorial design and 3^k factorial design, related problems

Confounding

Introduction, confounding in the 2^k and 3^k factorial design, partial confounding, related problems

Fractional factorial designs

Introduction, fractional replication of the 2^k factorial design-one-half, one-quarter and the general 2^{k-p} fractional factorial design, design of resolution III, IV and V, related problems

Regression analysis

Introduction, simple linear regression, hypothesis testing in simple linear regression, interval testing in simple linear regression, model adequacy checking-residual analysis, the lack-of-fit test, the coefficient of determination, Multiple linear regression, hypothesis testing in multiple linear regression, other linear regression models. Related problems

Response surface methodology

Introduction, the method of steepest ascent, analysis of quadratic models, response surface designs-designs for fitting the 1st order and 2nd order models, related problems

Recommended books

1. *Design and analysis of experiments* by Douglas C. Montgomery, John Wiley & Sons
2. *Experimental design* by Cochran & Cox
3. *How to generate optimal conditions*, Mir Publishers, Moscow

PHYSICAL METALLURGY

ME-8111

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Crystallography

Crystallography - space lattice - unit cell - classification of space lattices by crystal system - packing factor - indexing of crystal planes and directions in cubic and hexagonal system - defects in crystals - dislocation concepts - slip and twin crystal orientation.

Strengthening Mechanisms

Work hardening, solid solution strengthening, strengthens by heat treatment, precipitation hardening, grain refinement techniques.

Phase Transformations

Nucleation and crystal growth during solidification, important features of pearlitic, bainitic and martensitic transformations, basics of binary and ternary phase diagram, diffusion kinetics.

Iron Iron-Carbide Equilibrium Diagram

Introduction to iron-iron carbide diagram, TTT and CCT diagrams.

Overview of Metallic Materials

Plain carbon steels, low alloy and Q-T steels, dual phase steels, HSLA steels, Hadfield steel, stainless steels, tool steels, ultra-high strength steels- maraging steels, high strength aluminium alloys, titanium base alloys, nickel base super alloys.

Heat treatment

Annealing, normalizing, hardening and tempering, stress relieving, spheroidizing, case hardening – Carburizing, nitriding, cyaniding, flame hardening and induction hardening, hardenability-its measurement and its significance.

Corrosion

Introduction to various forms of corrosion and its prevention.

Books recommended:

1. S.H.Avner, "Introduction to Physical Metallurgy", McGraw Hill.
2. V.Raghavan, "Physical Metallurgy (Principles and Practice)", Prentice Hall.
3. D.S. Clarke and W.R.Varney, "Physical Metallurgy for Engineers", CBS.
4. T.V.Rajan, C.P.Sharma and Ashok Sharma, "Heat Treatment – Principles and Techniques", Prentice Hall of India.
5. Y.S Laktin, "Engineering Physical Metallurgy and Heat treatment", MIR publishers.
6. Metals Hand book , Volume I-VI, American Society of Metals.

CONVENTIONAL WELDING PROCESSES

ME-8112

L T P CREDITS
3 1 0 4

Introduction

Welding– Definition, industrial importance, applications; welding vs. other fabrication processes; classification of welding and allied processes.

Welding Safety and Hazards

Hazards associated with gas and arc welding processes, protection against electric shock, arc radiations, fumes and dust, compressed gases, fire and explosions.

Oxy Acetylene Welding (OAW)

Basic principle and equipment used; types of flames, their characteristics and applications; introduction to gas cutting.

Fundamentals of Arc Welding & Power Sources

Arc- arc characteristics- arc physics, arc plasma, arc structure, arc stability, arc efficiency; brief introduction to bead geometry and melting rate, mode of metal transfer- short circuit, globular and spray mode of transfer, various factors and forces affecting metal transfer; welding power sources- introduction to transformers, rectifiers, transistors, thyristers, diodes, inverters; basic principle and characteristics of welding transformers, rectifiers, generators and inverters; power source characteristics- static and dynamic volt-ampere characteristics, duty cycle; arc blow- causes and its control.

Shielded Metal Arc Welding (SMAW)

Basic principle and equipment used; welding parameters and their effect on weld bead characteristics; covered electrodes- functions of electrode coating, types of coating and their characteristics, classification and coding of covered electrodes as per IS & AWS standards; advantages, limitations and applications.

Gas Metal Arc Welding (GMAW)

Basic principle and equipment used; welding parameters and their effect on weld bead characteristics; shielding gases- types, characteristics and applications; pulsed MIG welding; introduction to flux cored arc welding; advantages, limitations and applications.

Gas Tungsten Arc Welding (GTAW)

Basic principle and equipment used; arc initiation method and arc stability; types of tungsten electrode and their applications; shielding gases and their applications; effect of polarity on weld characteristics, difference between SMAW and GTAW power sources, requirement for DC suppresser unit; pulse TIG welding; electrode contamination; advantages, limitations and applications.

Submerged Arc Welding (SAW)

Basic principle and equipment used; welding parameters and their effect on weld bead characteristics; SAW fluxes- classification and their characteristics; coding of flux wire combination as per BIS and AWS; introduction to multi-wire and multi power systems, strip cladding, narrow gap welding; advantages, limitations and applications.

Plasma Arc Welding (PAW)

Basic principle and equipment used; plasma forming and shielding gases; transferred and non-transferred arc modes; micro-plasma welding; advantages, limitations and applications.

Resistance Welding

Basic principle; Brief introduction to spot, seam, projection and flash butt welding; welding variables; heat balance; process capabilities and applications.

Books recommended

1. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.
2. H.B.Cary, "Modern Arc Welding Technology", Englewood Cliffs, Prentice Hall.
3. Leonard P Connor, Welding Hand book, Volume I-III, AWS.
4. Metals Hand book , Volume 6, American Society of Metals.
5. Dave Smith, "Welding skills and technology", McGraw Hill.
6. R.Little, "Welding Technology, TMH.

INSPECTION AND TESTING OF WELDS

ME-8113

L T P CREDITS
3 1 0 4

Introduction

Quality-Weld quality, quality assurance concept in welding; brief introduction to procedure and welders qualification, requirement of destructive and non-destructive testing for quality control of welds.

Welding Discontinuities and Defects

Welding discontinuities - undercut, porosity, inclusions, lack of penetration, lack of fusion, overlap, arc strike, etc. and their permissible limits.

Destructive Testing (DT)

Tensile test- testing procedure, types of test specimen, transverse, longitudinal and notched tensile tests; Bend test- testing procedure, evaluation of tested samples, root, face and side bend tests; Impact test- Charpy and Izod impact tests, evaluation of test results; Hardness test- Brinell, Vickers, Rockwell hardness tests, micro-hardness test; Fatigue test- fatigue failure, test procedure, recording of fatigue data, S-N diagram, Goodman diagram.

NON DESTRUCTIVE TESTING (NDT)

Dye Penetrant Testing (DPT) and Magnetic Particle Testing (MPT)

Visual inspection; dye penetrant testing – procedure, penetrant testing materials, penetrant testing method, sensitivity; applications and limitations; magnetic particle testing- definition and principle, longitudinal vs. circular magnetization, different magnetizing techniques, procedure, equipment sensitivity and limitation.

Radiography Testing (RT)

Production and properties of X-rays, γ -ray sources; Basic principle and procedure; radiographic imaging- sensitivity, film speed, exposure time, film density, image quality indicators; inspection techniques- single and double wall imaging techniques; applications and limitations; real time radiography; safety against radiation hazards.

Eddy current and Ultrasonic techniques

Eddy current testing – principle, instrument techniques, sensitivity, application and limitations; ultrasonic testing –principle of UT, basic properties of sound beam, ultrasonic transducers, inspection methods, technique for normal beam inspection, weld testing using angular probes, modes of display, immersion testing, advantage, limitations; acoustic emission testing (AET)– principles of AET.

Books recommended:

1. Metals Hand book (Mechanical Testing), Volume VIII, American Society of Metals.
2. S.V.Nadkarni, “Modern Arc Welding Technology”, Oxford & IBH.
3. Leonard P Connor, AWS Welding Hand book, Volume I, American Welding Society.
4. Baldev Raj, Jayakumar. T., Thavasimuthu. M., “Practical Non Destructive Testing”, Narosa.
5. Baldev Raj, Jayakumar. T., Thavasimuthu. M., “Non Destructive Testing of Welded Components”, Narosa.

WELDING METALURGY

ME-8211

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Weld Metal Solidification

Weld metal solidification - Epitaxial growth, columnar and dendritic structures and growth morphology- effect of welding parameters - absorption of gases - gas/metal and slag/metal reactions.

Weldability Tests

Weldability- definition, factors affecting weldability, various weldability tests.

Weld Thermal Cycles

Different zones of weldment, heat flow - temperature distribution and weld thermal cycles, cooling rate - influence of heat input, joint geometry, plate thickness and preheat, significance of thermal severity number.

Residual Stresses and Distortion

Residual stresses & Distortion - introduction, causes, methods of reducing them.

Welding Of Ferrous Materials

Phase transformations- weld CCT diagrams - carbon equivalent-preheating and post heating-weldability carbon of low alloy steels, hot cracking, cold cracking, welding monograms; welding of stainless steels (austenitic, ferritic, martensitic, duplex and precipitation hardenable stainless steels), use of Schaffler and DeLong diagrams, welding of cast irons – difficulties and remedial measures.

Welding Metallurgy of Non-Ferrous Materials

Welding of Cu, Al, Ti and Ni alloys – processes, procedures, difficulties, defects and remedial measures.

Books recommended:

1. Linnert G. E., 'Welding Metallurgy', Volume I and II, 4th Edition, AWS.
2. Granjon H., 'Fundamentals of Welding Metallurgy', Jaico Publishing House.
3. Kenneth Easterling, 'Introduction to Physical Metallurgy of Welding', 2nd Edition, Butterworth Heinmann.
4. Saferian D., 'The Metallurgy of Welding', Chapman and Hall.
5. Metals Hand book , Volume VI, American Society of Metals.
6. J.F.Lancaster, Metallurgy of Welding, Wood head.
7. Kou S., 'Welding Metallurgy', John Wiley.

REPAIR, RECLAMATION AND SURFACING

ME-8212

L T P CREDITS

3 1 0 4

Repair Welding

Various aspects to be considered for repair welding, Engineering aspects of repair, techno-economics, repair welding procedures for components made of steel casting and cast iron, full-mould process, AWA bath tub test for cast iron repair, special procedures to avoid post-repair stress relief heat treatments; half bead, temper bead techniques, usage of different alloys filler metals.

Repair Welding for specific applications

Damaged bends in gas transmission pipeline, heat exchanger repair techniques-explosive expansion, plugging, etc., creep damaged high temperature components, repair of cracked petroleum pressure vessel/reactor.

Surfacing and Reclamation

Surfacing- introduction, hardfacing, cladding, buildup and buttering; Some of the common surfacing applications- steel plants, power plants, earth moving equipments, agricultural implements, chemical & petrochemical industries, etc,

Surfacing Materials

Types of surfacing alloys- Iron based alloys, nickel based alloys, chromium based alloys, cobalt based alloys and copper based alloys; their characteristics; factors to be considered in selection of surfacing alloys.

Welding Processes/Techniques for surfacing

Capabilities of various processes with respect to surfacing and recent developments in these; concept of weld cladding, various techniques used for cladding, cladding materials, areas of applications; various thermal spraying techniques, spraying materials along with applications; use of different surface coatings along with areas of applications.

Books Recommended

1. Dobby R.E., Kent K.S., 'Repair and Reclamation', The Welding Institute, 1986
2. 'Maintenance Welding in Nuclear Power Plants', American Welding Society, 1988.
3. 'Recommended Practice for Repair welding and Fabrication Welding of Steel Casting', Steel Foundry Research Foundation , 1981.
4. Lim Cottrel C., The Welding Institute, 'Welding Cast Irons', 1991.
5. 'Weld Surfacing and Hardfacing'. The Welding Institute, 1987.
6. Nagendra Reddy A., 'Maintenance Welding Made Easy', Jaico Publishing House, 1997

ADVANCED WELDING PROCESSES

ME-8213

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3 1 0 4

Solid State Welding Processes

Friction and friction stir welding, ultrasonic welding, adhesive bonding, diffusion bonding, explosion welding- basic principle, process variables, weld characteristics advantages, limitations and applications.

High Energy Beam Welding Processes

Electron Beam Welding (EBW) - basic principle, equipment details, process characteristics, process variables, advantages, limitations and applications.

Laser Beam Welding (LBW) – principle of operation, different laser mediums, advantages, limitations and applications.

Electro Slag and Electro Gas Welding

Principle of operation, equipment details, process variations, advantages, limitations and applications.

Thermit Welding

Basic principle, thermit mixtures, applications.

Thermal Cutting

Oxy-Acetylene cutting-basic principle, metal powder cutting, chemical flux cutting, oxygen lancing; Arc cutting- brief introduction to oxygen arc cutting, air arc cutting, plasma arc cutting, metal arc cutting and gouging; advantages, limitations and applications of various techniques.

Brazing and Soldering

Introduction, brazing vs. soldering, various techniques, their advantages, limitations and applications; brazing & soldering consumables.

Underwater Welding

Introduction to wet and dry under water welding & cutting.

Welding in space

Introduction, welding techniques, difficulties and advantages.

Books recommended

1. S.V.Nadkarni, “Modern Arc Welding Technology”, Oxford & IBH.
2. H.B.Cary, “Modern Arc Welding Technology”, Englewood Cliffs, Prentice Hall.
3. Leonard P Connor, Welding Hand book, Volume I-III, AWS.
4. Metals Hand book , Volume 6, American Society of Metals.
5. Dave Smith, “Welding skills and technology”, McGraw Hill.
6. R.Little, “Welding Technology, TMH.

WELDING CODES AND STANDARDS

ME-9111

L T P CREDITS

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Welding Symbols

Primary and secondary weld symbols, various information and location of this information on welding symbol.

Structural Welding Codes

Introduction to structural welding code AWS D1.1, design requirements, allowable stress values, workmanship and inspection.

Petroleum Piping And Cross Country Pipeline Welding

Introduction to API 5L and API 1104; Process and product standards for manufacturing of pipes - welding procedure and welder qualification, field welding and inspection requirements.

Pressure Vessel Fabrication

Introduction to ASME section VIII- division I, design requirements, fabrication methods, joint categories, welding and inspection requirements, post weld heat treatment and hydro-testing.

Welding Procedure and Welder Qualification

Introduction to ASME section IX; introduction to Welding Procedure Specification (WPS)- essential, non-essential and supplementary essential variables, procedure qualification, Procedure Qualification Records (PQR); welders performance qualification, essential and non-essential variables, retest and re-qualification of welders.

Materials And Consumables

Introduction to ASME section II part A and C; introduction to materials standards and testing of materials, consumables testing and qualification as per ASME/AWS requirements.

Books Recommended:

1. AWS D1.1 Structural Welding Code
2. API 5L
3. API 1104
4. ASME Section VIII - Division 1
5. ASME Section IX
6. ASME Section II Part A and Part C

DESIGN OF WELDED STRUCTURES

ME-9112

L T P CREDITS
3 1 0 4

Introduction

Design considerations, type of welds and weld joints, joint efficiency, factor of safety, selection of edge preparation, types of loading.

Fundamentals of Design

Stresses-axial & shear, deflections, torsion, bending moment and shear force diagrams, moment of inertia, torque.

Static Loading

Permissible stress, allowable defects, computation of stresses in welds, weld size calculation, code requirement for statically loaded structures.

Dynamic Loading

Design for fluctuating and impact loading - dynamic behavior of joints - stress concentrations - fatigue analysis - fatigue improvement techniques - permissible stress - life prediction

Fracture Mechanics

Concept of stress intensity factors - LEFM and EPFM concepts - brittle fracture- transition temperature approach - fracture toughness testing, application of fracture mechanics to fatigue.

Costing For Welding

Definition of terms, composition of welding costs- equipment cost, cost of consumables, labor cost, overhead cost, total cost- method of calculating these costs. Standard time and method of calculating standard time.

Books Recommended

1. Omer W. B., 'Design of Weldments', James.F. Lincoln Arc Welding Foundation, 1991.
2. Gray T. G. E. 'Rational Welding Design', Butterworths.
3. Hertzberg R.W., 'Deformation and Fracture of Mechanics of Engineering Materials', John Wiley.
4. Dieter G., 'Mechanical Metallurgy', Tata McGraw Hill.
5. Guerey T.R., 'Fatigue of Welded Structure', Cambridge University Press.
6. Broek, "Elementary Engineering Fracture Mechanics", Kluwer Academic Publishers.
7. Wazirani & Ratwani, "Strength of Materials",

ROBOTICS

ME-8105A

L T P CREDITS
3 1 0 4

Introduction

Evolution of robot and robotics, laws of robotics, robot anatomy: links, joints, degree of freedom, arm configuration, wrist configuration, end-effector.

Coordinate frame, Mapping and Transforms

Coordinate frames, description of objects in space, transformation of vectors, inverting a homogeneous transform, fundamental rotation matrices.

Kinematics

Denavit-Hartenberg Notation, kinematic relationship between adjacent links, manipulator transformation matrix, inverse kinematics.

Linear and angular velocity of a rigid body, velocity propagation along links, manipulator jacobian.

Dynamics

Lagrange-Euler Formulation, Newton-Euler Formulation.

Control of manipulator

Position control, Force control: Applications of standard control strategies.

Books recommended

1. Mittal and Nagrath, Robotics and Control, TMH.
2. John J. Graig, Introduction to Robotics, Pearson Education.
3. Beer and Johnston, Vector mechanics, TMH.
4. Nise, Control system engineering, Wiley.
5. David Kelton, Simulation modeling and Analysis, Tata McGraw Hill.

FINITE ELEMENT METHODS

ME-8105 D

L T P CREDITS
3 1 0 4

Introduction

Historical Background, Stresses and equilibrium, Boundary Conditions, Strain-Displacement Relations, Stress-Strain Relations, Temperature Effects, Vectors and Matrices.

Introduction & Fundamental Concepts

Classification of Differential Equations, Rayleigh-Ritz Method, Galerkin's Method, Point Collocation Method, Least Square Method, Weighted Residual Method, Variational Formulation.

D F E Modeling

Finite Element Modeling Coordinates and Shape Functions, Generalized Coordinates, Natural Coordinates in 1D, 2D and 3D, Coordinate Transformation, Assembly of Global Stiffness matrix and Load vector, Properties of Stiffness Matrix, Treatment of Boundary Conditions and Temperature Effects. Truss and Beam Elements.

2-D FE Modeling ,Finite Element Modeling, Constant Strain Triangle (CST).

2-D FE Modeling

The Four Node Quadrilateral, Numerical Integration, Higher Order Elements; *Nine Node Quadrilateral, Eight Node Quadrilaterals, Six Node Triangle.*

Truss

Introduction, Plane Trusses, Assembly of Global Stiffness Matrix and load vector.

Higher-Order Elements

Plate Bending, C^0 and C^1 Elements, Non-conforming Elements and Patch Test.

Scalar Field Problems

Introduction, Steady-state heat transfer, Potential Flow, Fluid Flow in Ducts.

Dynamic Considerations

Element Mass Matrices, Evaluation of Eigen Values and Eigen Vectors. (Introduction only)

Computer Implementation

Introduction; Computer Program Organization for Calculation of System Matrices.

Recommended Books:

Chandrupatla and Belegundu, Introduction to Finite Elements in Engineering *Publisher* PHI

Bathe Finite Element Procedures *Publisher* PHI

Reddy An Introduction to Finite Element Method *Publisher* TMH

Huebner The Finite Element Methods for Engineers John Wiley

Zienkiewicz The Finite Element Method TMH

Buchanan Finite Element Analysis McGraw Hill

WELDING AUTOMATION

ME-8105E

L T P CREDITS
3 1 0 4

Introduction

Manual, semiautomatic, automatic and mechanized welding; welding processes suitable for automation; basic requirements of a welding power source for automation; recent developments in welding power sources; standard devices used for holding and traversing welding torches and jobs in pipe and plate welding, like welding fixtures, positioners, manipulators, column and boom, turning rolls, side beam carriage, orbital welding systems, etc.

Sensors

Thermal, electromagnetic, optical and sound sensors for sensing current, voltage, welding speed, temperature, no.of drops, etc., contact and non-contact sensors; seam tracking and adaptive control.

Computers in Welding

Off line planning like weld simulation, design, prediction of metallurgical changes and properties; computerized weld testing and inspection; computerized data acquisition and sensing systems; modeling of welds and welding processes; real time welding information and control systems; welding documentation (WPS, PQR, etc.); databases and knowledge base systems.

Robotics in Welding

Introduction to robots, robot selection and its applications for welding; programming of welding robots; tolerances of assemblies for robot welding; sensors and auxiliary devices for robot welding; new generation robots.

Books recommended

1. Welding robots, British welding Institute.
2. Proceedings of international conference on computer tech. in welding, IIW.
3. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.
4. T.H. North, Advanced Joining Technology, Chapman and Hall.
5. Leonard P connor, Welding Hand book, Vol. III, AWS.

COMPUTER AIDED ENGINEERING

ME-8105F

L T P CREDITS
3 1 0 4

Computer Aided Design (CAD)

Interaction devices and techniques, geometrical transformations, viewing in three dimensions, modeling and object hierarchy, raster algorithms, display, representation of 3D shapes, introduction to cading & rendering of surfaces and solids, hidden lines, edge and surface removal.

Finite Element Method

Modeling, shape functions, finite element equations, boundary conditions, quadratic shape functions, linear, triangular and four elements, numerical integration, softwares.

Computer Aided Manufacturing

Review of NC part programming, APT programming, computerized numerical control, adaptive control system. Industrial robots, Computer integrated Manufacturing Systems, DNC System, the manufacturing cell, flexible manufacturing systems, computer managing system, Enterprises Resource Planning (ERP), factory of the future.

Material handling and storage systems, group technology, quality control and automated inspection.

Computer networks for manufacturing, hierarchy, local area network, manufacturing automation protocol.

Books Recommended

1. Chandrupatla & Belegandu, Introduction to Finite Elements in Engineering, PHI.
2. Yoram Koren, Computer Control of Manufacturing System, Mcgraw Hill.
3. Mikell P. Grover, Automation, Production systems and Computer Integrated Manufacturing, PHI.
4. Ramamurthi, Computer Aided Mechanical Design & Analysis, TMH.

COMPOSITE MATERIALS AND THEIR MANUFACTURING

ME-8204B

L T P CREDITS
3 1 0 4

Introduction

General introduction to composites; historical background; concept of matrix and reinforcement and particulates.

Matrix and reinforcement

Types of matrix and reinforcement, volume fraction and weight fraction Fiber architecture fiber packing arrangements, whiskers

Fabrication methods of polymer composites

Liquid resin impregnated routes, pressurized consolidation of resin pre-pegs, consolidation of resin molding compounds, injection molding of thermoplastics, hot press molding of thermoplastics.

Fabrication of ceramic composites

Powder based routes, reactive processing, layered ceramic composites, carbon/carbon composites,

Fabrication routes of metal matrix composites

Squeeze infiltration, stir casting, spray deposition, powder blending and consolidation, diffusion bonding of foils, PVD

Testing and characterization

Different tests like internal stress measurement by diffraction, metallographic preparation etc with special emphasis to metal matrix composites

Secondary processing and application of composites

Secondary processing like machining, joining, extrusion of composites; Application and case studies.

Recommended Books:

S.C.Sharma Composite materials Narosa Publishers

R.K.Everret & R.J. Arsenault Metal matrix composite Academic press

T. W. Clyne & P. J. Withers Introduction to metal Matrix Composite Cambridge press

ADVANCED OPTIMIZATION TECHNIQUES

ME-8204C

L T P CREDITS

3 1 0 4

Linear programming

Modelling of linear programming problem – a few examples; Solution of linear programming problem – simplex method, two-phase method, M-method; Sensitivity analysis – graphical approach.

Non-linear programming

Convex and non-convex search space, Kuhn-Tucker conditions, Hessian matrix; Transformation of constrained optimization problems into unconstrained ones – penalty function approach; Direct search – variable elimination method, random search method.

Integer Programming

Modelling of integer programming problem – a few examples; Solution of integer programming problem – branch & bound algorithm, cutting-plane algorithm; Travelling salesman problem – formulation, solution and practical applications.

Heuristic models

Limitations of traditional optimization approaches to solve real world problems, Population based optimization techniques, Simple genetic algorithms – introduction, representation of variables, fitness function, genetic operators – reproduction, crossover, mutation; Advantages and limitations of population based optimization techniques over the point-to-point based ones.

Recommended Books:

Taha, H. A. Operations Research PHI

Deb, K. Optimization of Engineering Design PHI

D.S. Hira, P. K. Gupta Operations Research S. Chand

Rao Optimization techniques New Age international

WELDING COST AND ECONOMOICS

ME-8204E

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Factors influencing welding cost

Welding process, joint design, consumables, welding procedures-brief introductions.

Selections of welding process

Factors to be considered in selecting the welding process, their effect on total welding cost, cost curves for different processes.

Selection of joint design

Types of weld joints, cost involved in joint preparations, comparison of amount filler metal requirement for different joint design.

Welding consumables

Consumables for varies processes- their characteristics, (metal recovery, electrode efficiency, stub down away etc,) advantages and limitations of various types/ forms of consumables and their effect on over all welding cost.

Welding procedures

Various components of a welding procedure and their contribution toward welding cost, welding position- operator efficiency , operation factors, use of jigs, fixtures, petitioners and other mechanized welding system- their effect on welding cost.

Costing for welding

Definition for terms, composition of welding cost- equipment cost, cost of consumables, labor cost, over head cost, total cost- method of calculating these cost, standard time and method of calculating standard time.

Books Recommended

1. S.V. Nadkarni, Modern arc welding technology, Oxford & IBH
2. T.H. North, Advanced welding technology, chapman and Hall.
3. Leonard P Conner, Welding hand book, Volume III, AWS.
4. H.B. Caary, Modern arc welding technology.
5. R.S. Parmar, Welding processes and technology, Khanna publishers.

PRODUCT DESIGN & DEVELOPMENT

ME-8205C

L T P CREDITS

3 1 0 4

Stages in design process

Introduction to various stages of the design process: Formulation of problem, Generation of alternatives, Evaluation, Guided Redesign. Case study.

Product life cycle

New product introduction: early introduction, increased product life. Life cycle management tools: System integration, QFD, House of quality, Pugh's method, Pahl and Beitz method. Case studies.

Value engineering

Introduction, nature and measurement of value. Value analysis job plan. Creativity and techniques of creativity. Value analysis test. Case studies.

Concurrent/ reverse engineering

Introduction, basic principles, components, benefits of concurrent engineering. Concept of reverse engineering

Material selection

Materials in design. The evolution of engineering materials. Design tools and material data. Function, material, shape and process. Material selection strategy, attribute limits, selection process, computer aided material selection. Case studies.

Process selection

Introduction. Process classification: shaping, joining and finishing. Systematic process selection. Ranking, process cost. Computer – aided process selection.

Design for manufacture and assembly

Design for Manufacture and Assembly (DFMA). Reasons for not implementing DFMA. Advantages of DFMA with case studies. Design features and requirements with regard to assembly, production. Design for Manufacture in relation to any two manufacturing processes: machining and injection molding. Need, objectives.

Design for 'X'

Introduction. Design for: Safety, packaging and storage, quality, reliability, energy conservation, environment, aesthetics, ergonomics, maintenance, recyclability and disposal. Case studies.

Patents, liability and ethics

Introduction. Protecting your design: patents, copyright, basic tools of design protection. Liability issues in product design. Ethical considerations. Examples/ case studies.

Recommended Books:

Karl T. Ulrich, Steven D. Eppinger Product Design & Development Mc GrawHill

John M. Usher, Utpal Roy and H. R. Parasaei Integrated Product and Process Development
Tata McGraw Hill

G. Boothroyd, P. Dewhurst and W. Knight Product Design for Manufacture and Assembly
Marcel Dekker

SYSTEM ANALYSIS & DESIGN

ME-8205D

L T P CREDITS
3 1 0 4

System Components

The environment and the system concept; system structure; system inputs and outputs; system approach to macro problems; problem definition with system concepts and approach.

System Modeling

Model formulation; Representation of dynamics signal and system flow graph; System interactions; System compatibility; Sub-systems and inter-connections; Functional and equipment structuring. Linear graph approach. Time models.

System Dynamics

Dynamic analysis of systems; Dynamic behavior of organization; Total flow of man, information and materials; Dynamic analysis of the models for capital equipment and orders; Derivation of the policies for management based on system models

Optimization

Optimization of system performance; Perturbation analysis of system parameters; Criteria for optimization, Gradient method; Dynamic programming method.

System Design

Elements of Decision analysis; Game theory; Application of game and decision theory to system design. Techniques for creative design; Elementary sensitivity analysis.

Recommended Books:

Gosling, Design of Engg. Systems, John Wiley

A.D.Hall , System Engg., Van Nostrand, U.K.

Machol , System Engg. Handbook, McGraw Hill Inc

SAFTY IN WELDING

ME-8205E

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Concept of safety

Introductions, definitions, need of safety, factors affecting safety, safety and productivity.

Safety rules and regulations

The Factories Act 1948, factories act amendments in 1987 and their implications, salient features of the Amendments 1987, implications of the 1987 amendments.

Safety precautions against fire

Causes of industrial fire, preventive measures to be taken against fire, handling of the fire accidents.

Safety in welding

Causes of hazard associated with gas and arc welding processes. Protections against electric shock, arc radiations, fumes and dust, compressed gases, fire and explosions

Safety management technique

Safety inspections- procedures –periodicity-checklist-report form- planning for safety- safety sampling – safety audit- safety survey- incident recall technique- job safety analysis- damage control – disaster control.

Safety equipments

Various safety equipments, constructural features, handling, maintenance and repairs of safety equipments.

Books Recommended

Title	Author	Publisher
Manufacturing management	Moore	MGH
Industrial Engineering	OP Khanna	Dhanpat Rai
Hand Book of Industrial Engineering	Maymard	MGH
Welding Process and Tech.	RS Parmar	Khanna

WELDING APPLICATION TECHNOLOGY

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Power generation equipment

Heat exchangers, power cycle piping, super heaters, reheaters, economizer, auxiliary pipe materials, welding and testing/ inspections.

Petroleum and refinery piping

Materials, processes, fabrications techniques and filled welding.

Structural's, ship building and automobiles

Materials, processes, fabrications and constructions, use of automatic welding and system in automobiles industry, automations, testing and inspection.

Boilers and pressure vessels

Materials, processes, fabrications, inspection and testing.

Nuclear and aerospace

Materials, processes, fabrications, inspections and testing, reasons and stringent quality control measures.

Recommended books

- 1 American Welding Society, 'Guide for Steel Hull Welding'
2. Gooch T. S., 'Review of Overlay Welding Procedure for Light Water Nuclear Pressure Vessels, American Welding Society.
3. Winter Mark H., Materials and Welding In Off- Shore Constructions, Elsevier.
4. Welding Institute in Canada. 'Welding for challenging environment' Pergamon Press.
5. Lincoln Arc Welding Foundations, 'Modern Welding Structures' Volume I- IV.
6. Lincoln Arc Welding Foundations, ' Arc Welding Projects', Volume I and II.
7. Lincoln Arc Welding Foundations, 'Arc welding in manufacturing and Constructions', Volume I and II
8. Adams C.M. and Corrigan, 'Mechanical and Metallurgical behavior of Restrained welds in Submarine steels', American Welding Society.