

**DEPARTMENT OF CIVIL & MECHANICAL
ENGINEERING**

BIR TIKENDRAJIT UNIVERSITY, IMPHAL MANIPUR



SYLLABUS

for

M.Tech in Civil Engineering & Mechanical Engineering

With effect from 2020-2021

Department of Civil Engineering, Bir Tikendrajit University

Master of Technology in Construction Technology and Management

Course Structure

Semester	Paper Code	Title of the Paper	Credits (L-T-P)	Total
I	CE-CM-001	Project Planning and Management	3-0-0	
	CE-CM-002	Contract Administration and Management	3-0-0	
	CE-CM-003	Construction Equipment and Methods	3-0-0	
	CE-CE-004	Construction Engineering Practices	3-0-0	
	CE-CP-005	Practical	0-0-3	
II	CE-CM-006	Civil Engineering Materials	3-0-0	
	CE-CM-007	Contracts and Legal Issues	3-0-0	
	CE-CM-008	Safety Management	3-0-0	
	CE-CE-009	Urban Transportation Planning	3-0-0	
	CE-CP-010	Practical/Seminar	0-0-3	
III	CE-CM-011	Projects		
IV	CE-CM-012	Projects		

Project Planning and Management

Contract Formats: FIDIC, CPWD, Special Conditions of Contract (SCC)

Construction contracts: Contract specification, types of contract documents used for construction, RED Flag Clauses

Contract procedure: Disputes, arbitration and litigation procedure-preparation, settlement, evidence.

Contract Execution

Roles & Responsibilities, Contractor's Liabilities

Contracts – Change Management

Change management process & procedures, Contract communication & Documentation

Reading:

1. Allen E, Iano, J, Fundamentals of Building Construction subscription E Book, Material and Method, John Wiley and Sons, 2011.
2. Cameron K. Andres, Ronald C. Smith, Principles and Practices of Commercial Construction, 8th Ed., Prentice Hall, 2009.
3. Acts And Contract Documents: The Indian Contract Act, 1872;The Arbitration and Conciliation Act, 1996 as amended on Dec 2015;General Conditions of Contract for Central P.W.D. Works, 2014; FIDIC Conditions of contract – Red Book - 1999

Contract Administration and Management

Module 1: Contracts Administration

Professional ethics, standard forms of building contracts, conditions of contracts, Contract formation, contracts with various stakeholders on a major Construction projects, rights of owners, adjoining owners and third parties, project management consultants, contractor, contract performance, contract correspondence and contract closure, Global tenders and B.O.T. System.

Module 2: Contract System and Acts

Various types, Importance & clauses of contract, The Indian Contract Act (1872): Objectives of the act, Definition of the contract, Valid, Voidable, and Void contracts, Sale of Goods Act.

Module 3: Construction Claims, Injunctions and Bailment

Extra items and causes of claims, Types of construction claims, documentation, settlement of claims, and extension of time, Injunctions, Types:- temporary, perpetual, mandatory, Indemnity & Guarantee- difference between the two, Contracts of Guarantee & Indemnity, Consideration for Guarantee, Surety's liability, discharge of surety, Bailment- Nature of transaction, delivery of bailee.

Module 4: Arbitration Awards & Dispute Resolving boards

Indian Arbitration Act, arbitration agreement, conduct of arbitration, power and duties of arbitrator, rules of evidence/ preparation and publication of awards, methods of enforcement, impeding and award, Limitations of arbitration in the Indian context (DRB_s) Dispute resolving boards-necessity, formation, functioning advantages, Causes of disputes and importance of role of various stakeholders in prevention of disputes, Alternate Dispute Resolution methods- mediation, conciliation.

Module 5: Industrial Act and Labour Laws

Industrial Dispute Acts, payment of wages act, Minimum Wages Act, Indian Trade Union Act, and Workmen's Compensation Act. Labour welfare fund act 1953.

Module 6: Administration of Incentive Schemes

Necessity, Merit rating, job evaluation, installation, modification and maintaining and incentive scheme based on implementation experience.

References:

1. B. N Dutta, Estimating and Costing in Civil Engineering: Theory and Practice Published S. Dutta & Company, Lucknow._
2. B. S. Patil, Civil Engineering Contracts and Estimates -Universities Press (India) Private Limited, 2006.
3. Joseph T. Bockrath, Contracts and the Legal Environment for Engineers and Architects, McGraw Hill, 2000.
4. Kwaku, A., Tenah, P.E. Jose M. Guevara, P.E., Fundamentals of Construction Management and organisation, Printice Hall, 1985.M.M.Tripathi Private Ltd., Bombay, 1982.
5. Gajaria G.T., Laws Relating to Building and Engineering Contracts in India,

Construction Engineering Practices

Concrete Construction methods: form work design and scaffolding, slip form and other moving forms, pumping of concrete and grouting mass concreting (roller compacted concrete), ready mixed concrete, various methods of placing and handling concrete, Accelerated curing, Hot and cold weather concreting, Under water concreting, Pre-stressing.

Reference Books:

1. Robertwade Brown, Practical foundation engineering hand book, McGraw Hill Publications, 1995
2. Patrick Powers .J, Construction Dewatering: New Methods and Applications John Wiley & Sons, 1992
3. Jerry Irvine, Advanced Construction Techniques CA Rockers, 1984
4. Peurifoy, R.L., Ledbetter, W.B. and Schexnayder. C, Construction Planning Equipment and Methods, McGraw Hill. Singapore 1995
5. Sharma S.C. Construction Equipment and Management, Khanna Publishers, Delhi, 1988
6. Deodhar, S.V. Construction Equipment and Job Planning Khanna Publishers Delhi, 1988
7. Dr. Mahesh Varma, Construction Equipment and its planning and application, Metropolitan Book Company, New Delhi 1983

Civil Engineering Materials

Cement selection for civil works. Concrete making materials. Fresh concrete and its theology properties. Mechanical, deformational behavior and microstructure of hardened concrete. Creep and shrinkage. Laboratory testing of concrete. Durability of plain and reinforced concrete, Structural steels including alloyed and cold - worked steels.

Reference Books:

- 1) Metha P.K and Monteiro.P.J.M, " CONCRETE", Microstructure, Properties and Materials, Third Edition, Tata McGraw- Hill Publishing company Limited, New Delhi, 2006
- 2) Shetty .M.S., " Concrete Technology, Theory and Practice", Revised Edition, S. Chand & company Ltd., New Delhi,2006
- 3) Neville. A.M. , " Properties of Concrete", 4th Edition Longman,1995
- 4) Mindass and Young, " Concrete", Prentice Hall.1998

Contracts and Legal Issues

Execution of Works – Direct execution by Department – Muster Roll (form 21) – Piece work agreement – Work Order. Execution through contractor – Definitions – Types of contracts – Lump sum contract, Item rate contract, Cost plus fixed fee contract, Cost plus percentage contract, Special contracts.

Contract document – Conditions of Contract – Tender notice – Bidding procedure – Scrutiny and acceptance of tender, award of contract – Earnest money deposit and Security deposit - Termination of contract. Disputes – Settlement through arbitration – Indian Arbitration Act 1940 – Clauses and advantages of arbitration.

Specifications – Importance, Design and Writing of Specifications – Types of Specifications – General, Detailed, Standard, Special, Restricted and Manufacturer's specifications.

Accounts – Advances, Earnest money and Security deposits, First and final bills, Fines, Recovery, Closing of accounts.

Labour legislation – Factory Act 1948, Contract Labour Act 1970, Trade Union Act, Minimum Wages Act 1948, Workmen Compensation Act 1923, Industrial Disputes Act 1947. Labour Welfare – Labour welfare fund act 1965, Employees State Insurance act 1948, Incentives, Labour welfare measures.

Reference Books

1. *Construction Management and Accounts* by B.L.Gupta and Amit Gupta
2. *Construction Management and Projects* by B.Sengupta and H Guha
3. *Construction Planning and Management* by P.S.Gelhot and BM Dhir.

Safety Management

Safety management function, line versus staff authority, safety responsibility and accountability in construction industry. Safety and its importance in construction industry, hazards in construction projects, causes of accidents, cost of an accident.

Experience Modification Rating, Workers insurance, general safety programs in construction industry, construction safety problems. Case based reasoning, case indexing, retrieval, accident prevention and forecasting using CBR method.

Systems safety analysis, faulty tree analysis, failure modes and effects analysis in construction industry.

Reference Books

1. *Safety Management* by John V. Grimaldi, (1996). AITBS Publishers & Distributors, New Delhi, India.
2. *Construction Project Administration* by A.A.Kwakye, (1997), Adisson Wesley Longman, London.

Urban Transportation Planning

Travel Demand Concept: Demand function: Independent variables: Travel attributes; Assumptions in Travel demand estimation; Sequential, Sequential recursive and Simultaneous process.

Data Collection and Inventories: Study area definition; Zoning principles; Travel data collection - Road side interview, Home interview; IPT surveys; Sampling techniques; Expansion factors; Use of Secondary sources in data collection.

Travel Demand Estimation: Four step Travel Demand Forecasting approach; Trip generation Analysis; Zonal models Category analysis; Household models; Trip attraction of work centres.

Trip Distribution: Mode Factor methods; Gravity model; opportunity model.

Mode Split Analysis: Mode choice behavior; computing modes; Diversion curves; Probabilistic approaches.

Traffic Assignment: Traffic network and coding; Minimum path trees; All or nothing assignment; Capacity restraint assignment; Corridor Identification; Plan preparation and Evaluation; Deficiency analysis.

Reference Books

1. *Introduction to Transportation Planning* by M.J.Bruton; Hutchinson of London Ltd.
2. *Introduction to Urban System Planning* by B.G.Hutchinson; Mc Gra Hill.
3. *Urban Transportation Planning Guide - Roads & Transportation AS~C(i<:tion of Canada; University of Toronto Press.*
4. *Traffic Engineering and Transport Planning* by Kadiyali L.R. Khanna Publishers.

Department of Civil Engineering, Bir Tikendrajit University

Master of Technology in Environmental Engineering

Course Structure

Semester	Paper Code	Title of the Paper	Credits (L-T-P)	Total
	CE-EE-013	Environmental chemistry and microbiology	3-0-0	
	CE- EE -014	Air pollution and control	3-0-0	

I	CE- EE -015	Design of Water Supply and Sewerage Systems	3-0-0	
	CE-EL-016	Computational Methods	3-0-0	
	CE-EP-017	Environmental Engineering Lab	0-0-3	
II	CE- EE -018	Solid waste management & EIA	3-0-0	
	CE- EE -019	Waste Treatment Systems	3-0-0	
	CE- EE -020	Hydrological & Hydraulic Modelling	3-0-2	
	CE- EL -021	Digital Image Processing and Applications	3-0-0	
	CE- EP -022	Practical	0-0-3	
III	CE- EE -023	Projects	0-0-24	
IV	CE- EE -024	Projects	0-0-24	

Environmental chemistry and microbiology

General Chemistry:-Basic principles – chemical equations – types of chemical reactions - calculations from chemical equations; gas laws; Equilibrium and Le Chatelier’s Principle – factors affecting chemical equilibrium - activity and activity coefficient - ionic strength.

Physical Chemistry:- Thermodynamics – heat and work – enthalpy – entropy – free energy – temperature dependence of equilibrium constant; membrane processes; principles of solvent extraction; electrochemistry; chemical kinetics; adsorption.

Equilibrium Chemistry:- Variations of Equilibrium relationships; ways of shifting chemical equilibrium; solutions to equilibrium problems -acid base equilibrium – solubility equilibrium – oxidation reduction equilibrium.

Organic Chemistry and Biochemistry:- Organic compounds of interest to environmental engineers, general properties of the functional groups of organic compounds; Enzymes, classification enzymes catalyzed reaction, energy considerations coupling of reaction; Breakdown and synthesis of carbohydrates, fats, proteins under aerobic and anaerobic reactions; CNP cycles under aerobic and anaerobic reactions; Concepts of BOD, COD, TOC.

Environmental Chemistry:- Fundamentals of surface and colloidal chemistry; chemistry involved in water treatment; Atmospheric chemistry; soil chemistry; emerging pollutants and sources of pollution for water, air and soil

Environmental Microbiology:- Introduction of microbiology, classification and characterization of microorganisms, viruses; Morphology and structure of bacteria, nutrient requirement, growth of bacteria; Basic microbiology of water and sewage; Basic principals involved in the analysis of fecal indicator bacteria – coli forms and streptococci, plankton analysis, analysis of pseudomonas & streptococci; Pathways of aerobic and anaerobic metabolism, Energy transfer in metabolism; Kinetics of microbial growth. Microbiology of water, wastewater, soil and air.

Readings:

1. Sawyer, C. N., McCarty, P. L., and Perkin, G.F., Chemistry for Environmental Engineering and Science, 5thEd., McGraw-Hill Inc., 2002
2. Benefield D. L., Judkins F. J., Weand L. B., Process Chemistry for Water and Wastewater Treatment, 1st Ed., Prentice Hall, 1982
3. Bitton, G., Wastewater Microbiology, 3rd Ed., Wiley, 2005
4. Mitchell, R., and Gu, J.D., Environmental Microbiology, 2nd Ed., Wiley-Blackwell, 2010
5. Eugene Weiner R., Applications of Environmental Chemistry - A Practical Guide for Environmental Professionals, 1st Ed., Lewis Publishers, 2000

Air Pollution And Control

Air-pollution – Historical Perspective , definition, sources, classification, effect on plants, effect on human health.

Air quality monitoring-Ambient and Stack monitoring; Emission inventory, Air Pollution Meteorology-Dynamics of Pollutant dispersion, Diffusion, Dispersion, Advection, Flux , Atmospheric Stability, ABL, Albedo, Bowen Ratio, wind rose, Gaussian Plume model.

Urban Air Pollution- Air Pollution from vehicles; Air Pollution from Biomass burning ; Air Pollution from landfills, Industries-case studies, Air Pollution control, Air pollution indices, standards, norms, rules and regulations.

Indoor Air Pollution-Causes and Effects ; Case studies

Reference:

- 1 Vallero, D.A. Environmental Contaminants Assessment and Control. Academic Press, Elsevier, 2004.
2. T.J. Lyons and W.D. Scott .Principles of air-pollution meteorology, CBS Publishers, 2001
3. Wadden, R.A., Scheff, P.A., Indoor Air Pollution: Characterization, Prediction, Control. Wiley, New York, 1983
4. Vallero D., Fundamentals of Air Pollution, 4th edition, Academic Press, 2007

DESIGN OF WATER SUPPLY AND SEWERAGE SYSTEMS

Need for Transport of water- Sources of water and quality- Planning of water supply systems, Selection of water treatment trains, Selection of Pumps- Characteristics-Economics; Selection of pipe materials, Jointing, Laying and Maintenance, Water distribution pipe networks- Design, analysis and optimization Water hammer analysis; Appurtenances –Corrosion prevention – Minimization of water losses – Leak detection- SCADA systems- Specific contaminant removal systems.

Wastewater Sources and flow rates, Characteristics, Standards of Disposal, Treatment Objective and Strategies, Sewage collection systems; Sanitary sewer design, Biological Treatment Processes: Types, Kinetics of Plug Flow and Completely Mixed Systems- low cost sanitation systems; Treated wastewater reuse/recycle.

Water treatment residuals and Wastewater sludge management and disposal. Use of computer software in water transmission, water distribution, wastewater collection.

Readings:

1. McGhee, T. J., Water Supply and Sewerage, 7th Ed., McGraw Hill International, 2007
2. Quasim, S. R., Motley E. M. and Zhu, G., Water Works Engineering- Planning, Design and Operation, Prentice Hall, 2000
3. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw Hill., 1984
4. Nazih K. Shammas, Lawrence K. Wang, Water Supply and Wastewater Removal, 3rd Edition, John Wiley & Sons, Inc, 2011
5. CPHEEO, Manual on Water Supply and Treatment, 3rd Ed., Ministry of Urban Development, New Delhi, May 1999.
6. CPHEEO, Manual on Operation and Maintenance of Water Supply Systems, Ministry of Urban Development, New Delhi, January 2005.
7. CPHEEO, Manual on Sewerage and Sewage Treatment, 3rd Ed., Ministry of Urban Development, New Delhi, November 2013.

Computational Methods

Review of numerical techniques for finding roots of non-linear equations and numerical integration. Ordinary differential equations, nature of problems, boundary and initial equations, Euler's method, modified Euler's method, Predictor-Corrector methods, Runge-Kutta methods, Boundary value problems, Applications for reservoir routing, gradually varied flow problems, pipe networks

Partial differential equations, classification, nature of problems, Concepts of finite difference method, finite difference schemes, Solution of parabolic equations, pollutant transport, Solution of elliptical equations, solution of Laplace equation and Poisson equation, flow through porous media, Solution of hyperbolic equation, method of characteristics, unsteady flow through open channels, propagation of waves, Concepts of finite volume method.

Basic concepts of Finite Element Method, FEM vs FDM, Element shapes, shape functions, development of shape functions for linear elements, Formulation of FEM for stress analysis problems, flow through porous media, Galerkin's method and Variational method for formulation of stiffness matrix.

Reading:

1. Hoffman, J.D., (2011), "*Numerical Methods for Engineers and Scientists*", CRC Press, Special Indian Edition
2. Kotteguda, N.T. and Renzo Resso, (1998), "*Statistics, Probability and Reliability for Civil and Environmental Engineers*", McGraw Hill Companies Inc., New York
3. Schilling, R.J., and S.L. Harris, (2007), "*Applied Numerical Methods for Engineering*", CENGAGE Learning, India Edition
4. Abbot, M.A. and Vervev (1996), "*Computational Hydraulics*", Elsevier Publications

Environmental Engineering Lab

Estimation of Solids, Acidity, Alkalinity, Hardness, Chlorides and Fluorides
Determination of pH and Conductivity
Estimation of Biochemical Oxygen Demand
Estimation of Chemical Oxygen Demand
Estimation of Nitrogen (Different Forms like Ammonia, Nitrite, Nitrate)
Estimation of Phosphates and Sulphates
Estimation of Residual Chlorine Determination of Available Chlorine in bleaching powder
Conducting Break Point Chlorination Test
Determination of Residual Chlorine

Determination of Dissolved Oxygen Atomic Absorption Spectrophotometric
Determination of Heavy Metals
Determination of Biochemical Oxygen Demand
Conducting Jar test for determining optimum dosage of coagulant
Estimation of Organic Compounds Using HPLC
Estimation of biological parameters
Batch studies on heavy metal removal and their analysis Using Ion Analyser

Solid Waste Management & EIA

Solid Waste: Origin, characteristics, Quantity and Analysis; Effects of Solid Wastes; Storage, Collection, Transportation of Solid wastes; Solid waste transformation; Product recovery processes; Sanitary landfills; Legislation in solid waste. Hazardous waste: definition, generation, classification; Magnitude of problem; Risk assessment; Environmental Legislation; Characterization and site assessment; Waste minimization and resource recovery; Storage and Transportation of Hazardous wastes; Hazard in processing and treatment; Physical, Chemical, Thermal and Biological processes; Hazardous waste disposal; Landfill disposal and land storage; Ground water contamination; Containment; remedial alternatives. Environmental impact assessment (EIA), definitions and concepts, rationale and historical development of EIA, sustainable development, Initial environmental examination, environmental impact statement, environmental appraisal, environmental impact factors and areas of consideration, measurement of environmental impact, organization, scope and methodologies of EIA, status of EIA in India.

Text Books:

1. Tchobanoglous, G., Theisen and Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill, 1993
2. LaGrega, M. D., Buckingham, P. L. and Evans, J. C., Hazardous Waste Management, 2nd Ed., McGraw Hill, 2001.
3. Larry W Canter, Environmental Impact Assessment, 2nd Ed, McGraw-Hill, 1997.

Waste Treatment Systems

Introduction: Wastewater Characteristics, Standards of Disposal, Treatment Objective and, Strategies, Layouts of Primary, Secondary and Advanced Treatment Units. Design Of Preliminary And Primary Treatment Operations: Screens, Grit Chambers, Skimming Tank, Primary and Secondary Sedimentation Tanks. Biological Treatment Processes: Types, Kinetics of Plug Flow and Completely Mixed Systems. Attached Growth Processes: Trickling Filters (Standard Rate, High Rate), Biofilters, Practices, Features and Design, Operational Difficulties and Remedial Measures, Rotating Biological Contactors. Suspended Growth Processes: Activated Sludge Process, Modifications and Design Equations, Process Design Criteria, Oxygen and Nutrient Requirements - Classification and Design of Oxidation Ponds, Lagoons. Sludge Treatment And Disposal: Sludge Thickening, Aerobic and

Anaerobic Sludge Digestion Processes, Design of Digester Tank, Sludge Dewatering, Ultimate Disposal, Sludge Drying Beds, Other Methods of Sludge Treatment.

Text books:

1. Benefield L.D. and Randall C.D., Biological Process Designs for Wastewater Treatment, Prentice Hall Pub. Co., 1980
2. Metcalf and Eddy, Wastewater Engineering – Collection, Treatment, Disposal and Reuse, 4 th Ed., McGraw Hill Pub. Co., 2003
3. Udo Wiesmann, In Su Choi and Eva-Maria Dombrowski, Fundamentals of Biological Wastewater Treatment, 1st Ed., Wiley, 2007

Hydrologic Elements & Applied Hydrology

Basic concepts of hydrology; structure and composition of atmosphere, air mass, cold and warm fronts; atmospheric temperature and its variations; vapor pressure and relative humidity; evaporation and evapotranspiration; types and forms of precipitation; measurement of precipitation and other atmospheric parameters; hydrograph analysis; probability, risk and uncertainty analysis for hydrologic and hydraulic design; flood routing –hydrologic and hydraulic routing - developing algorithms; hydrologic real time forecasting; urban hydrology; time series analysis.

Texts:

1. Chow, V.T., Maidment, D.R., Mays, L.W., Applied Hydrology, McGraw Hill, 1988.
2. Todd, D.K., Ground Water Hydrology, Wiley, New York, 1998.

Digital Image Processing and Applications

Image Interpretation, Principles of Image Interpretation, Types of Imaging, Elements of image Interpretation, Techniques of visual Interpretation, Generations of Thematic maps. Digital Image Data Format: Band sequential format (BSQ), Band interleaved by Line (BIL), Color composites: Generation of B/W and False Colour Composites (FCC). Image Rectification and Restoration, Radiometric and Geometric distortions, Geometric and Radiometric corrections, atmospheric corrections, illumination and view angle effects, Interpolation techniques: nearest neighbour, bilinear and cubic convolution, Image Enhancement, Image Classification, Unsupervised classification, Supervised classification: Parallelepiped, Minimum Distance to Means, Gaussian Maximum Likelihood, Hybrid Methods and Decision Tree classifiers, classification accuracy assessment.

Text Book:

1. Remote Sensing and Image Interpretation, 6th edition, T. Lillesand, R. Kiefer and J. Chipman, John Wiley.
2. Introductory Digital Image Processing – A Remote Sensing Perspective, 3rd edition, J. Jensen, Prentice Hall.

Department of Mechanical Engineering, Bir Tikendrajit University

Master of Technology in Manufacturing Technology

Course Structure

Semester	Paper Code	Title of the Paper	Credits (L-T-P)	Total
I	CE-MT-021	Advanced Engineering Mathematics	3-1-0	
	CE-MT-022	Machining Science and Machine Tools	3-0-0	
	CE-MT-023	Industrial Management	3-0-0	
	CE-ME-024	Industrial Robotics	3-0-0	
	CE-MP-024	Practical	0-0-3	
II	CE-MT-025	Quality & Reliability Engineering	3-0-0	
	CE-MT-026	Automated Manufacturing System	3-0-0	
	CE-MT-027	Modern Manufacturing Processes	3-0-0	
	CE-ME-028	Computer Control of machines and Processes	3-0-0	
	CE-MP-030	Practical	0-0-3	
III	CE-MT-029	Projects		
IV	CE-MT-030	Projects		

Advanced Engineering Mathematics

Statistics: Elements of statistics; frequency distribution; Concept of mean, median, mode and different types of distribution; Standard deviation and variance; Curve fitting by least square method;

Matrix Operation: Matrix operation; Eigen value and Eigen Vector by iterative methods; Diagonalisation of a square matrix.

Laplace Transform, Fourier Transform and their Applications;

Numerical Methods: Interpolation by Polynomials; Error Analysis; Solution of System of linear equation by Gauss-Seidel iterative method; Newton Rapson method; Numerical Integration by Gauss-quadrature; Solution of ordinary differential equation by Rayleigh-Ritz method.

Ordinary Differential Equation: i) 2nd Order homogeneous Equation ii) Euler Cauchy Equation, iii) Non homogenous linear equation. **Partial Differential Equation :** i) Wave equation – one dimension and two dimension, ii) Heat equation – one dimension and two dimension

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BOOKS:

1. S.S. Sastry- *“Introductory Methods of Numerical Analysis”*, PHI
2. M.K.Jain, S.R.K. Iyengar, R., K.Jain; - *“Numerical Methods for Scientific and Engineering Computation”* New Age International Pub.
3. A.M. Goon, M.K.Gupta, B.Dasgupta; - *“An Outline of Statistical Theory” Volume I, II*, The World Press Private Ltd.
4. Yu.P.Adler, E.V. Markova, Ylu V. Granovsky; - *“The Design of Experiments to find Optimal Conditions”*, MIR, 1975, Moscow
5. Erwin Kreyszig - *Advanced Engineering Mathematics*, John Wiley & Sons, Inc
6. Stanley Grossman and William R.Derrick- *Advanced Engineering Mathematics*-.Harper & Row Publishers

Machining Science and Machine Tools

Geometry of Cutting Tools:

Turning tools interrelations between different systems of rake angles; interrelationships between clearance angles; Milling cutters; Twist drills; Grinding of single point cutting tools.

Mechanism of Chip Formation:

Observation methods; Chip formation analysis; Dynamic shear strain; Criticism of single shear plane theory; Effect of cutting variables on chip reduction coefficient; Different types of chips; Chip curl and cross section.

Force in Machining:

Merchant's circle diagram for analysis of forces; Velocity relationships; Kronenberg's relationship; Dynamometry.

Heat in Metal cutting:

Heat sources; Measurement of cutting temperature.

Machinability & Machining Economics

Machinability and machining efficiency; Machining economics.

Cutting Tool Materials:

Failure of cutting tools; Essential properties of cutting tools; Development of tool materials- carbide, HPC, CBN, diamond.

Machine Tools Automation (Mechanical Control):

Basic concepts and operating cycles of automatic machine tools (AMT); cam controlled AMT; Hydraulically operated and controlled AMT, Hydraulic Servosystems; Electromechanical Controls.

BOOKS:

1. Milton C. Shaw- *Metal Cutting Principles* , Oxford University Press
2. N.K.Meheta - *Machine Tools Design*, Tata McGraw -Hill Publishing
3. G.Kuppuswamy - *Principles of Metal Cutting*, Universities Press
4. S.K.Basu&D.K. Pal- *Design of Machine Tools* Oxford & IBH Publishing Co.
5. Edited by N.Acherkan- *Machine Tool Design : 4 vols.* , Mir Publishers, Moscow
6. A.Bhattacharya- *Metal Cutting Theory and Practice*, New Central Book Agency (P) Ltd.

INDUSTRIAL MANAGEMENT

Classification and Importance of Operations Management:

Operations Management in corporate profitability and competitiveness; Operations strategy; Types and characteristics of manufacturing systems and service systems;

Operations Planning and Control:

Forecasting for operations; Inventory planning and control; Materials requirement planning; Planning production in aggregate terms; Operations scheduling;

Quality Assurance:

The quality assurance system; choice of process and reliability; control of quality;

Management Information System:

Need and structure of MIS; Data Processing Systems; Data Sources and Management

Human Resource Management 7

Concept and evolution; Manpower planning; recruitment and selection; Motivating personnel; Leadership;

REFERENCE

1. Buffa and Sarin – *Modern Production / Operations Management*, 8th ed., John Wiley & Sons (Asia) Pvt. Ltd.
2. Russell & Taylor – *Operations Management*, Wiley India Pvt. Ltd.
3. Larry Long – *Management Information Systems*, Prentice Hall
4. A.Leon– *Enterprise Resource Planning*, TMH
5. Gupta, C.B. – *Human Resource Management*, Sultan Chand & Sons

INDUSTRIAL ROBOTICS

Introduction:

History of robotics; Definition of robot; Main components of robot: manipulator, sensors, controller, power conversion unit; Robot geometry: types of joints, workspace, number of degrees of freedom; Common configurations used in arms: rectangular, cylindrical, spherical, jointed; Classification of robots according to coordinate system: Cartesian, cylindrical polar, articulated or jointed; Classification of robots according to control method: non-servo, servo; Robot specifications: payload, accuracy, repeatability, resolution, maximum tip speed, reach, stroke;

Robot End Effector

End effector: definition, gripper, tools; Gripper : main parts, source of power; Types of grippers: mechanical grippers, vacuum cups, magnetic grippers, adhesive grippers, hooks , scoops, ladles; Universal gripper; Robot Tools: spot welding gun, pneumatic impact wrench, pneumatic nut runner, stud-welding head, inert gas welding torch, heating torch, grinder, spray painting gun.

Robot Actuators:

Definition, Characteristics: power to weight ratio, stiffness, compliance, reduction gears; Conventional actuators: hydraulic actuator, pneumatic actuator, electric motor, direct drive motor, stepper motor; servo motor; Special actuators: magnetostrictive, shape memory, alloy, elastomer, Mc Kibben artificial muscle;

Robot Sensors:

Definition of Sensor and transducer; Calibration; Basic categories of measuring devices: analog, discrete; Main types of sensors: position, velocity, acceleration, force and pressure, torque, touch and tactile, proximity, sniff, vision, voice recognition.

Robot Vision:

Definition of digital image, generation of digital image; Robot Vision System: definition, use, functions, components, classification, vision cameras; Techniques of image processing and analysis: Image data reduction, segmentation, feature extraction, object recognition; Application of robot vision system.

Robot Programming

Definition of robot programming; Different methods of robot programming: teach-pendant programming, key board programming; Programming languages: VALII, AML/2, ARM BASIC

Industrial Application of Robots

Material Transfer; Machine loading and unloading, Processing operations, Assembly operations, Inspection.

BOOKS:

1. Klafter, Richard D. Chmielewaski, Thomas A. and Negin, Michael (2001) - *Robotic Engineering*, Prentice-Hall of India Pvt. Limited.
2. Groover, Mikell P. Weiss, Mitchell., Nagel, Roger N., Odrey, Nicholas G.(1986) - *Industrial Robotics : Technology, Programming and Applications*, McGraw-Hill International Edition

3. Niku, Saeed B. (2001)- *Introduction to Robotics Analysis, Systems, Applications*, Prentice Hall of India Private Limited, New Delhi
4. Shilling, Robert J. (1990)- *Fundamentals of Robotics : Analysis & Control*, Prentice Hall of India, New Delhi
5. Koren, Yoram (1987)- *Robotics for Engineers*, McGraw-Hill Book Company, Singapore
6. Hall, Ernest L. Hall Bettie C. (1985)- *Robotics: A User-Friendly Introduction*, Holt, Rinehart and Winston, Holt-Saunders, Japan
7. Yoshikawa, Tsuneo (1990) *Foundations of Robotics : Analysis and Control*, Prentice Hall of India Private Limited, New Delhi
8. Mason, Matthew T. (2005), *Mechanics of Robotic Manipulation*, Prentice Hall of India Private Limited, New Delhi

QUALITY AND RELIABILITY ENGINEERING

Introduction:

Evolution of quality control; Quality: Definitions of quality, dimensions of quality of a product, dimensions of quality for service variables, attributes, defect, standard or specification, quality of design, quality of conformance, quality of performance; Quality Control: off-line quality control, statistical process controls, acceptance sampling plan; quality assurance, quality circles, quality improvement.

Total Quality Management:

Main themes of TQM: customer, process, people; Features of TQM model; Vision and Quality policy; Performance standards; Six sigma quality, Quality function deployment; Benchmarking; Quality auditing; vendor selection and certification; Different TQM practices; ISO 9000, Malcolm Baldrige National Quality Award, International Quality Study; leading sages and Quality and their philosophy; W.Edwards Deming, Joseph M. Juran, Kaoru Ishikawa, Taguchi, Philip Crosby, Armand Feigenbaums;

Measures of Quality Product and Quality Process

Definitions and use of cost of quality, traditional cost of quality, cost elements of cost of quality: prevention cost, appraisal cost, internal failure cost, external failure cost, cost of quality report, limitations of cost of quality, emerging cost of quality model, uses of quality cost information, intangible cost.

Continual Improvement: Basic Tools

Kaizen, continuous improvement, continual improvement, types of data, population, sample, data summarization, methods of data summarization; tally sheet, frequency distributions, histogram, stem-and leaf display, bar chart, Pareto chart, Pareto diagram, line graph or run chart, flow chart, cause-and-effect diagram, check sheet, box-plots, scatter diagrams or scatter plots, seven step method for continuous improvement, PDCA cycle.

Continual Improvement: Statistical Process Control

Seven basic statement tools, different types of variation in the process outputs, definition of control chart, distinction between attributes and variables, control charts for attributes; p-charts, np-charts, c-charts, u charts; control charts for variables.

X-bar chart, R chart, individual chart; out-of control patterns; descriptive statistics and inferential statistics, Probability distribution, random variable, variance and standard deviation, normal distribution, behaviour of samples, Central Limit Theorem.

Continual Improvement: Some Advanced Tools

Different approaches for problem solving adopted by management, brainstorming: traditional, electronic; Affinity diagram; Process capability: Relative Precision Index, Process Potential Index; Six Sigma Quality, Taguchi methods: Total loss function, design of experiments, reduction in variation, statistically planned experiments.

Defining Reliability

Reliability, demand time, one shot items, repeated cycles, time dependent items of specified mission continuously operating items, items in standby.

Basic statistics – The Binomial distribution, the Poisson distribution, the Exponential distribution, the log normal distribution, the weibull distribution.

Reliability Parameters

Reliability as a function of time, failure rate as a function of time, constant failure rate, mission reliability, mean time to failure (MTTF), MTTF as a function of failure rate, mean time between failures (MTBF), mean down time (MDT), availability, complex system, increasing failure rate, Bath tub curve.

Reliability Predictions

Condition for the prediction, cycle dependent performance, confidence estimates for success probability, confidence estimates for MTBF & constant failure rate, MTBF estimates, failure rate estimates, effects of environment and stress – accelerated testing.

Reference:

1. Paul Kales - *Reliability for Technology, Engineering and Management*. – Prentice Hall
2. Bikas Bhadury & S.K.Basu - *Terotechnology : Reliability Engineering and Maintenance Management* – Asian Books Private Limited
3. E. Balguruswamy - *Reliability Engineering* – Tata McGraw Hill Publishing Co-Limited.
4. Amitava Mitra - *Fundamentals of Quality Control and Improvement* – Prentice Hall of India Pvt. Ltd., New Delhi
5. Jill A.Swift, Joel E. Ross and Vincent K.Omachonu - *Principles of Total Quality* – St. Lucie Press Boca
6. William J. Kolarik - *Creating Quality : Concept, Systems, Strategies and Tools* – McGraw-Hill Inc.
7. Donna C.S.Summers - *Quality*– Prentice Hall, International Inc, New Jersey
8. Douglas C.Montgomery- *Introduction to Statistical Quality Control* – John Wiley & Sons Incs, New York
9. Bertrand L.Hansen and Prabhakar M.Ghare - *Quality Control and Application* – Prentice Hall of India Pvt. Ltd., New Delhi
10. Samuel K.Ho - *TQM: An Integrated Approach* – Kogen page India Pvt. Ltd., New Delhi
11. D.J.Smith-*Reliability Engineering* – Pitman

Automated Manufacturing System

Introduction

Developments in manufacturing technology in automation, A hierarchical model of factory automation, Systems requirements and automatic control technology, Classification of NC systems

2Features of numerically controlled machines

Fundamentals of machining, Design considerations of NC machine tools, Methods of improving machine accuracy, Increasing productivity with NC machines, Machining centers, CNC controllers.

Fundamentals of NC part programming

Preparatory functions, Axis motion commands, Feed and speed commands, Miscellaneous command, , Conventional numerical control, Direct numerical control, Computer numerical control, Computer aided part programming, APT language basics, CAD/CAM based part programming

Manufacturing Planning and Control Systems

A basic framework for manufacturing and planning, Demand management, Aggregate production planning, Master production schedule, Material requirement planning, MRP lot sizing problem, Capacity planning, Shop floor control

Group Technology and Cellular Manufacturing Systems

Concept of Group Technology, Design attributes and manufacturing features, GT implementations, Part family formation, Selection of classification and coding system, Benefits of group technology, Concept of cellular manufacturing, Cell formation approaches, Economics of group tooling in cellular manufacturing, Production planning and control in cellular manufacturing

Flexible Manufacturing Systems

Concept of different types of flexibility, Volume variety relationship for understanding production systems, Key characteristics of various manufacturing systems, Concept of FMS, Basic features of physical components of FMS, Basic features of control components of an FMS, Operational problems in FMS, Layout considerations Sequencing of Robot moves in Robotic cell, FMS benefits

Enterprise Integration CIM, Future Trends

Introduction to CIM, Network communication, Networks architecture and protocol, Database managements systems, Realizing CIM

BOOKS:

1. Thomas A. Boucher- '*Computer Automation in Manufacturing: An Introduction*', Chapman and Hall
2. Yoram Koren - '*Computer Control of Manufacturing Systems*', Macgraw Hill International Book Company
3. Nanua Singh - '*System Approach in Computer Integrated Design and Manufacturing*', John Wiley and Sons, Inc.
4. Narahari and Viswanadham - "*Performance Modelling and Analysis of Automated Manufacturing systems*" Prentice Hall
5. James G.Bralla - "*Handbook of product design for manufacture* ", McGraw Hill Book co.,1986
6. Henry Peck, "*Designing for manufacture* ", Sir issac Pitman & Sons Ltd.,1973.
7. Matousek, "*Engineering Design* ", Blackie & Sons,1956.

Modern Manufacturing Processes

Introduction

Various modern manufacturing processes.

Mechanical Machining Processes

Abrasive Jet Machining (AJM), Ultrasonic Machining (USM), Abrasive Finishing Processes – Abrasive Flow Finishing (AFF), Magnetic Abrasive Finishing (MAF), Water Jet Machining (WJM), Abrasive Water Jet Machining (AWJM).

Thermoelectric Machining Processes

Electric Discharge Machining (EDM), Electric Discharge Grinding and Electric Discharge Diamond Grinding, Wire Electric Discharge Machining, Laser Beam Machining (LBM), Plasma Arc Machining (PAM), Electron Beam Machining (EBM).

Electrochemical and Chemical Manufacturing Processes

Electrochemical Machining (ECM), Electromechanical Grinding (ECG), Electrochemical Drilling (ECD), Electrochemical Deburring (ECDe), Chemical Machining (ChM)

High Velocity Forming Processes

Explosive forming processes, Propellant forming, Electro-Hydraulic forming, Electromagnetic forming, Pneumatic / Mechanical forming

Micro-Machining, MEMS and Nanotechnology

Classification of Micromachining, Various Micromachining Processes- Abrasive micro machining, Ultrasonic micro machining, Micro EDM, Micro ECM, Laser Micromachining. MEMS (Micro Electro Mechanical Systems)- Development and need of MEMS, overview of MEMS technology with relevant non conventional processes. Nano materials, Nano tubes and Nano wires, Nanofabrication.

BOOKS:

1. V.K.Jain – *Advanced Machining Processes*, Allied Publishers Pvt. Limited, India
2. P.K.Misra - *Non-conventional Machining*, Narosa Publishers,
3. Pandey & Shan - *Modern Machining Processes*, Tata McGraw Hill
4. Mark Ratner, Daniel Ratner – *A general introduction to the Next Big Idea Nano technology* Pearson Education.
5. G.F.Benedict – *Non-traditional Machining Processes*, Marcel Dekker Inc.,
6. J.A.McGeough, *Advanced Methods of Machining*, Chapman and Hall
7. Amitava Ghosh & Ashok Kumar Mullick– *Manufacturing Science*, West Press Pvt. Ltd.
8. Joseph McGeough – *Micromachining of Engineering Materials*, Marcel Dekker
9. Mikell P.Groover – *Fundamental of Modern Manufacturing: Materials, Processes and Syste*, Willey

COMPUTER CONTROL OF MACHINES AND PROCESSES

Introduction:

Computer in process control, Hierarchical Control, Control Networks, Interfacing, Computer Communication : Transmission, Coding, Types of communication lines, communication hardware; Network Architecture: Open System Inter Connector (OSI), LAN, Manufacturing Automation Protocol (MAP), Databases in Control, Control Hierarchy, Control Computers, Discrete event system and supervisory controller software design : Petri net modeling, mathematical properties of ordinary Petri nets, software specification for a machining cell controller.

Numerical Control Machines :

Type of CNC Machines: CNC plasma machines, CNC spring forming machines, CNC laser cutting machines, vertical machining centers, horizontal machining centers, variable axes machining control, CNC Press brakes, CNC Punch press; Point-to-point machines, continuous path machines; machines tool axes, components of CNC machines; NC / CNC controls, CRT displays, drive motors, stepping motors and open-loop systems, servo motors and closed loop system, CNC machine; axes and coordinate systems; absolute and incremental programming, word address programming, part programming, programming procedure, incremental positioning, circular interpolation, tool length offset, tool diameter offset.

Robot Technology

Definition of Robot; robot anatomy; joints and links, common robot configurations; Robot Control Systems; Drive Systems, Types of robot control; Accuracy and Repeatability; End Effectors; Sensors in Robotics; Types of Robot Programming: manual setup, lead through programming, robot programming languages, off-line programming.

Automated Material Handling:

Material handling function; Types of material handling equipment; Analysis of Material handling Systems: consideration of material and movement conditions, material handling analysis techniques; Design of the System: effect of plant layout, principles of material handling; Conveyor Systems: types of conveyors, quantitative relationships and analysis of conveyor systems; Automated Guided Vehicle Systems (AGVS): types of AGVS, applications, vehicle guidance and routing, traffic control and safety, system management, quantitative analysis of AGV Systems.

Automated Storage Systems:

Storage System Performance : Types of materials stored in factory, storage capacity, system throughput, storage transactions, utilization, uptime reliability; Automated Storage / Retrieval Systems (AS/RS); Definition, important categories of automated storage /retrieval system, basic components of an AS /RS, AS/RS controls, special features, applications, quantitative analysis, caruousel storage systems: Configuration and control features, Coruousel storage application, Quantitative analysis; Work-in Process Storage : Interfacing handling and storage with manufacturing : types of interface, positional accuracy, methods of load transfer.

Computer Process Control:

Definition : Computer – process interface : characteristics of manufacturing process data, process data input / output; Interface hardware : sensors and transducers, analog-to-digital converters, digital-to-analog converters, multiplexers, pulse counters and pulse generators; Computer Process Monitoring, Types of computer process control: preplanned control, direct digital control, supervisory computer control; Programming for computer process control: requirements of control programming, interrupt system, error detection and recovery, diagnostics;

Sequence Control and Programmable Controllers:

Logic control and sequencing : logic control system, sequencing system; Logic control elements: logical AND, OR, and NOT gates, boolean algebra, hardware for implementing combinational systems; sequencing elements; Timers, Counters; Ladder Logic Diagrams; Programmable Logic Controllers (PLC): Components of PLC, Programming the PLC, How the PLC operates, Additional capabilities of PLC.

BOOKS:

1. Mikell P.Groover – *Automation, Production Systems and Computer – Integrated Manufacturing*, Prentice Hall of India Pvt. Ltd.
2. HMT Limited *Mechatronics*, Tata Mc Graw – Hill Publishing Company Ltd.
3. Jon Stenerson and Kelly Curran– *Computer Numerical Control : Operation and Programming* , Prentice Hall, New Jersey
4. S.Kant.Vajpayee- *Principles of computer – Integrated Manufacturing*, Prentice Hall of India.
5. Thomas O. Boucher- *Computer Automation in Manufacturing: An Introduction*, Chapman & Hall
6. David J.Williams- *Manufacturing Systems: An Introduction to the Technologies*: Halsted Press
7. James V.Valentino and Joseph Goldenberg (2000) – *Introduction to Computer Numerical Control* – Prentice Hall
8. G.E. Thyer (1988) – *Computer Numerical Control of Machine Tools*– Newnes, Butterworth-Heinemann Ltd., Oxford