

**Dr. A.P. J. ABDUL KALAM TECHNICAL UNIVERSITY,  
LUCKNOW**



**Syllabus**

**4<sup>th</sup> Year**

**[Effective from session 2016-17]**

**B. Tech. Civil Engineering**

**Dr. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW**

**Study & Evaluation Scheme**

B Tech Civil Engineering

Effective from session 2016-17

Final Year, VII Semester

S No	Course Code	SUBJECT	PERIODS			Evaluation Scheme				Subject Total	Credit
			L	T	P	Sessional Exam			ESE		
						CT	TA	Total			
<b>THEORY SUBJECT</b>											
1	NOE071- NOE074	Open Elective – I	3	1	0	30	20	50	100	150	4
2	NCE031- NCE035	Department Elective-III	3	1	0	30	20	50	100	150	4
3	NCE041- NCE044	Department Elective-IV	3	1	0	30	20	50	100	150	4
4	NCE701	Design of Steel Structures	3	1	0	30	20	50	100	150	4
5	NCE702	Water Resources Engg	3	1	0	30	20	50	100	150	4
<b>PRACTICAL / DESIGN / DRAWING</b>											
6	NCE751	Seminar	0	0	4		-	50	-	50	1
7	NCE752	Industrial Training**					-	50	-	50	1
8	NCE753	Project#	0	0	4		-	100	-	100	3
9	NGP 701	General Proficiency	-	-	-	-	-	50	-	50	1
		<b>Total</b>	<b>15</b>	<b>5</b>	<b>8</b>					<b>1000</b>	<b>26</b>

\*\* 4 weeks Industrial Training after VI semester to be evaluated in VII semester.

# Project should be initiated in VII semester beginning and should be completed by the end of VIII semester.

Departmental Elective-3 (Full Unit Course with Credit: 4)

S. No.	Code and Course
2 (A)	NCE 031 - Bridge Engineering
2 (B)	NCE 032 - Finite Element Methods
2(C)	NCE 033 - Environmental Geo-technology
2(D)	NCE 034 - Industrial Pollution Control & Env. Audit
2 (E)	NCE 035 – Engineering Hydrology

Departmental Elective-4 (Full Unit Course with Credit: 4)

S. No.	Code and Course
3 (A)	NCE 041 - Precast and Modular Construction Practices
3 (B)	NCE 042 - Plastic Analysis of Structures
3 (C)	NCE 043 - Open Channel Flow
3 (D)	NCE 044 – Tunnel Engineering

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**Study & Evaluation Scheme**

B Tech Civil Engineering

Effective from session 2016-17

Final Year, VIII Semester

S No	Course Code	SUBJECT	PERIODS			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Exam		ESE			
						CT	TA				Total
THEORY SUBJECT											
1	NOE081- NOE084	Open Elective – II	3	1	0	30	20	50	100	150	4
2	NCE051- NCE054	Departmental Elective-V	3	1	0	30	20	50	100	150	4
3	NCE061- NCE064	Departmental Elective-VI	3	1	0	30	20	50	100	150	4
4	NCE801	Transportation Engineering -II	3	1	0	30	20	50	100	150	3
PRACTICAL / DESIGN / DRAWING											
5	NCE851	Project	0	0	12		100	100	250	350	8
6	NGP 801	General Proficiency	-	-	-	-	-	50	-	50	1
		Total	12	4	12					1000	24

Departmental Elective-5 (Full Unit Course with Credit: 4)

S. No.	Code and Course
2 (A)	NCE 051 - Computer Aided Design
2 (B)	NCE 052 - Analysis and Design of Hydraulic Structures
2 (C)	NCE 053 - Water Resources Systems
2 (D)	NCE 054 - Machine Foundation Design

Departmental Elective-6 (Full Unit Course with Credit: 4)

S. No.	Code and Course
3 (A)	NCE061 - Ground Improvement Techniques
3 (B)	NCE 062 - River Engineering
3 (C)	NCE 063 – Groundwater Management
3 (D)	NCE 064 - Earthquake Resistant Design of Structures

# List of Open Electives for B. Tech. Courses

## **OPEN ELECTIVE-I**

NOE -071	Entrepreneurship Development
NOE-072	Quality Management
NOE-073	Operations Research
NOE-074	Introduction to Biotechnology

## **OPEN ELECTIVE-II**

NOE-081	Non Conventional Energy Resources
NOE-082	Nonlinear Dynamic Systems
NOE-083	Product Development
NOE-084	Automation & Robotics

# NCE-701 Design of Steel Structures

L – 3, T – 1 CT – 30, TA – 20, ESE – 100

## **Unit - 1**

### **General Considerations**

Introduction, Advantages of Steel as a Structural Material, Disadvantages of Steel as a Structural Material, Structural Steel, Stress-Strain Curve for Mild Steel, Rolled Steel Sections, Convention for Member Axes, Loads, Dead Load, Live Loads, Environmental Loads, Seismic Forces, Snow and Rain Loads, Erection Loads, Basis for Design, Design Philosophies, Local Buckling of Plate Elements.

### **Introduction to Limit State Design**

Introduction, Limit States for Steel Design, Limit States of Strength, Limit States of Serviceability, Actions (Loads), Probabilistic Basis for Design, Design Criteria 8

## **Unit -2**

### **Simple Connections--Riveted, Bolted and Pinned Connections**

Introduction, Riveted Connections, Patterns of Riveted Joints, Bolted Connections, Types of Bolts, Types of Bolted Joints, Load Transfer Mechanism, Failure of Bolted Joints, Specification for Bolted Joints, Bearing-Type Connections, Prying Action, Tensile Strength of Plate, Efficiency of the Joint, Combined Shear and Tension, Slip-Critical Connections, Combined Shear and Tension for Slip-Critical Connections, Working Load Design, Design of eccentric bolted connections .

### **Simple Welded Connections**

Introduction, Types, Symbols, Welding Process, Weld Defects, Inspection of Welds, Assumptions in the Analysis of Welded Joints, Design of Groove Welds, Design of Fillet Welds, Fillet Weld Applied to the Edge of A Plate Or Section, Fillet Weld for Truss Members, Design of Intermittent Fillet Welds, Plug and Slot Welds, Stresses Due To Individual Forces, Combination of Stresses, Failure of Welds, Distortion of Welded Parts, Fillet Weld Vs Butt Weld, Welded Jointed Vs Bolted and Riveted Joints, Design of eccentric welded connections, Working Load Design. 8

## **Unit – 3**

### **Tension Members**

Introduction, Types of Tension Members, Net Sectional Area, Effective Net Area, Types of Failure, Design Strength of Tension Members, Slenderness Ratio ( $\lambda$ ), Displacement, Design of Tension Member, Lug Angles, Splices, Gusset Plate, Working Load Design. 8

## **Unit – 4**

### **Compression Members**

Introduction, Effective Length, Slenderness Ratio ( $\lambda$ ), Types of Sections, Types of Buckling, Classification of Cross Sections, Column Formula, Design Strength, Design of Axially Loaded Compression Members, Built-Up Columns (Latticed Columns), Lacing, Batten, Compression Member Composed of Two Components Back-to-Back, Splices, Design of Column Bases. 8

## **Unit – 5**

### **Beams**

Introduction, Types of Sections, Behaviour of Beam in Flexure, Section Classification, Lateral Stability of Beams, Lateral-Torsional Buckling, Bending Strength of Beams, Laterally Supported Beams, Laterally Unsupported Beams, Shear Strength of Beams, Web Buckling, Bearing Strength, Web Crippling, Deflection, Design Procedure of Rolled Beams, Built-Up Beams (Plated Beams), Purlins, Beam Bearing Plates, Effect of Holes in Beam, Introduction to Plate Girder , Introduction to Gantry Girder. 8

### **Text Books**

1. Design of Steel Structures by N. Subramanian, Oxford University Press
2. Limit State Design of Steel Structures by S. K. Duggal, Tata Mcgraw Hill.
3. Design of Steel Structures by K S Sairam, Pearson Education
4. Design of Steel Structures by S Ramamurtham, DhanpatRai Publishing Company.

### **Reference Books**

1. Steel Structures by Robert Englekirk. Hohn Wiley & sons inc.
2. Structural Steel Design by Lambert tall (Ronald Press Comp. Newyork.
3. Design of steel structures by Willam T Segui , CENGAGE Learning
4. Structural Steel Design By D MacLaughlin , CENGAGE Learning

# **NCE – 702 WATER RESOURCES ENGINEERING**

L – 3, T – 1 CT – 30, TA – 20, ESE – 100

## **UNIT – I**

Hydrology : Hydrologic Cycle. Water Budget Equation, Hydrologic system, Precipitation : Types, measurements and analysis, error in estimation, missing data, consistency of rainfall records, Intensity during frequency (IDF) and probabilistic maximum Precipitation (PMP) curves.

Evaporation and consumptive use: Process affecting factors, estimation and measurement techniques.

**Infiltration** : Process affecting factors, measurement and estimation, Infiltration Indices. 8

## **UNIT – II**

Surface Runoff: Components and factors affecting runoff, methods of estimation of runoff volume and peak runoff, rating curve, Rainfall – runoff relationships Hydrograph analysis: components, factors affecting hydrographs, base flow separation, Direct Runoff Hydrograph, Unit Hydrograph: Theory and assumptions. Derivation of Unit Hydrograph, Synthetic Unit Hydrograph Introduction to computer models for rainfall runoff analysis.

Irrigation: Developments in India, Necessity and types Advantages & disadvantages of irrigation.

Functions of water in plant growth, Methods of Irrigation, Water requirement of crops. Irrigation frequency, Irrigation efficiencies, Principal crops and crop season, crop rotation.

Canal irrigation: Classes and alignment, Parts of a canal system, Commanded area, curves in channels, channel losses. 8

## **UNIT – III**

Sediment Transportation: Suspended and Bed load and its estimation

Irrigation channels: Types: lined and unlined, silt theories: Kennedy's and Lacey's Design procedure for irrigation channels, Longitudinal cross section, Schedule of area

statistics and channel dimensions, use of Garret's Diagrams in channel design, cross sections of an Irrigation channel, Computer programs for design of channels

Lining of Irrigation Canals: Advantages and types, factors for selection of a particular type, design of lined channels, cross section of lined channels, Economics of canal lining. Water Logging: Definition, effects, causes and anti-water logging measures, Drainage of water logged land, Types of drains open and closed, spacing of closed drains. 8

## **UNIT – IV**

Regulation and control of canal system: Purpose, Types of canal regulation works and their functional aspects

Irrigation Outlets: Requirements, types, non-modular, semi-module and rigid module, selection criterion

River Training: Objective and need, classification of rivers, and river training works, meandering, stages, methods of river training, bank protection, Methods for measurement of discharge. 8

## **UNIT – V**

Ground Water Hydrology: Zones of underground water, Aquifers and their types, important terms, Determination of discharge through unconfined and confined aquifers with steady flow conditions, Interference among wells, determination of aquifer constants, Well loss and specific capacity, efficiency of a well, types of water wells, bored and open wells, specific yield of a well, Relative merits of well and canal irrigation, type of tube wells, well surrounding and well development, Suitable site selection for a tube well, Types of open wells, Methods of lifting water. Infiltration galleries. 8

## **Text Book**

1. Irrigation Engg. and Hydraulic Structures by S.K. Garg, Khanna Publishers.
2. Irrigation and water Power engineering by B.C. Punmia, Laxmi Publications.
3. Engineering Hydrology by K. Subramanya, TMH.
4. Irrigation Water Power and Water Resource Engg. by K.R. Arora.
5. Water resource engineering by Ralph A. Wurbs & Wesley P. James, Pearson Publication.

**References**

1. Water Resources Engg. By Larry W. Mays, John Wiley India
2. Water resources Engg. By Wurbs and James, John wiley India
3. Water Resources Engg. By R. K. Linsley, McGraw Hill
4. Irrigation and water Resources Engg. By G L Asawa, New age International Publishers
5. Irrigation Theory and practices by A.M. Michel.
6. Fundamental of Hydraulic Engineering System by Houghalen, Pearson Publication.



## NCE - 801 TRANSPORTATION ENGINEERING - II

L – 3, T – 1 CT – 30, TA – 20, ESE – 100

### UNIT –I

#### **Introduction, Permanent Way and Components:**

History and administrative setup of Indian Railways; Rails, Type of rails, rail gauges, permanent way formation,– functions, requirements, sections in embankment and cutting (single/double track), electrified tracks, locomotives, wheel and axle arrangement, coning of wheels, defect in rails, rail fastenings, Fish plates, spikes, chairs, keys, bearing plates. sleepers, Timber, steel, cast iron, concrete and prestressed concrete sleepers, sleeper density, ballast: material, specifications. 8

### UNIT-II

#### **Track Geometrics, Turnouts and Crossings, Stations and Yards:**

Railway alignment, vertical alignment – gradients and grade effects, horizontal alignment – horizontal curves, super-elevation, concepts of cant excess and deficiency, safe permissible speed, transition curves, widening of gauges and track clearances, points and crossings – terminologies, types of turnouts, design of turnouts, types of crossings, design of crossings. Different types of stations and Yards: classification and functioning. 8

### UNIT –III

**Signalling and Interlocking, Urban Railways:** Classification of Signals, method of train working, absolute block system, Centralized train control system, ATS, interlocking of track, principle of interlocking, types of interlocking, high speed track – track requirement, speed limitations, high speed technologies, Urban railway- railway system in urban areas. 8

### UNIT – 4

#### **Introduction to Airport Engineering**

Air craft characteristics affecting airport planning & design, selection of site for an airport. Airports - layout and orientation, Runway and taxiway design consideration and geometric design. Airport drainage management, Zoning laws, Visual aids and air traffic control, Runway lighting, Runway operation Helipads, hangers, service equipment. 8

### UNIT – 5

#### **Water Transport**

Harbours and ports, Types of Harbours; Harbours - layouts, shipping lanes, anchoring, location identification; Littoral transport with erosion and deposition; sounding methods; Dry and Wet docks, components and operational Tidal data and analyses.

Inland waterways: advantages and disadvantages; Development in India. Inland water operation. 8

### **Text Books**

1. A Text Book of Railway Engineering by S. P. Arora & S. C. Saxena
2. Railway Engineering by M. M. Aggrawal.

### **References**

1. Railway Engineering by Rangwala (Charotar Publishing House).
2. Airport Engineering by Rangwala (Charotar Publishing House).
3. Airport Planning & Design by Khanna , Arora & Jain Nem Chand & Brothers).
4. Docs & Harbour Engineering by Bindra (Dhanpat Rai Publishing Company).
5. Docs & Harbour Engineering by Rangwala (Charotar Publishing House).
6. Docs & Harbour Engineering by Oza (Charotar Publishing House).

## NCE 031 Bridge Engineering

L T P  
3 1 0

### Unit – 1

Site selection, various types of bridges and their suitability, loads, forces and IRC bridge loading and permissible stresses, Design of RC bridges under concentrated loads using effective width and Pigeauds Method, 8

### Unit – 2

Courbon's method of load distribution. Detail design of Reinforced Concrete slab culvert 8

### Unit – 3

T-beam bridge, box culverts, 8

### Unit – 4

Design elements of plate girder, economical section and design. 8

### Unit – 5

Design of piers, pier caps and Abutments, different types of bearings & its design 8

### Text Books :

1. Essentials of Bridge Engineering by D J Victor
2. Limit State Design of Steel Structures by S K Duggal
3. Design of steel Structures by Ramchandra
4. Bridge Engineering by S.Ponnusway
5. Principles & Practices of Bridge Engineering by S.P. Bindra
6. Bridge Engineering (An integrated Treatise) by V.V. Sastry

## NCE 032 Finite Element Methods

L T P  
3 1 0

### Unit - 1

Calculus of variation, Introduction to calculus of variations, Introduction to equilibrium equations in elasticity, Euler's Lagrange's equations, Principal of virtual work, virtual displacements, Principles of minimum potential energy, boundary value, initial value problems, Flexibility approach, Displacement approach, Different problems in structural analysis. 8

### Unit - 2

FEM Procedure, Derivation of FEM equations by variation principle polynomials, Concept of shape functions, Derivation for linear simplex element, Need for integral forms, Interpolation polynomials in global and local coordinates. Weighted residual Methods: Concept of weighted residual method, Derivation of FEM equations by Galerkin's method, Solving cantilever beam problem by Galerkin's approach, Derivation of shape functions for CST triangular elements, Shape functions for rectangular elements, Shape functions for quadrilateral elements. 10

### Unit - 3

Higher order Elements: Concept of iso-parametric elements, Concept of sub-parametric and super-parametric elements, Concept of Jacobin matrix.  
Numerical Integration: Numerical Integration, one point formula and two point formula for 2D formula, Different problems of numerical integration evaluation of element stiffness matrix, Automatic mesh generation schemes, 8

### Unit - 4

Pascal's triangle law for 2D shape functions polynomial, Pascal's triangle law for 3D shape function polynomials, Shape function for beam elements, Hermitian shape functions.  
Convergence: Convergence criteria, Compatibility requirements, Geometric isotropy invariance, Shape functions for iso-parametric elements, Special characteristics of stiffness matrix, Direct method for deriving shape functions using Lagrange's formula, Plane stress problems. 8

### Unit - 5

Analysis of structures: Truss elements, Analysis of truss problems by direct stiffness method. Analysis of frames and different problems, Different axi-symmetric truss problems. 6

**Text Book:**

1. The Finite Element method -ZIENKIEWICZ.O.C.Tata McGraw Hill Pub. New Delhi, 2000
2. Finite Element Methods by C R Alaval , PHI
3. Finite Elements in Engineering:- Chandrupatta, et. Al. Prentice Hall of India Pvt. Ltd.,
4. Finite element method with application in engineering by Chandrupatla & Belegundu, Pearson Publication.
5. Finite Element Method Basics concept & Applications by Alawala
6. Fundamental of Finite element Analysis by Devid V. hutton
7. Finite element Methods is fundamentals an application in engineering by Chen Z

**Reference Books:**

1. Concepts and Applications of Finite Element Analysis: COOK. D. Robert. Malus.S.David, Plesha E. Michel, John wiley & sons 3rd Edn. New York, 2000
2. Finite Element Analysis -C.S. Krishnanmoorthy, Tata McGraw Hill Publishing Co. Ltd, New Delhi,
3. Introduction to the Finite Element method -Desai / ABEL-C.B.S. Publishers & Distributors, New

**NCE 033 Environmental Geotechnology**

L T P  
3 1 0

**Unit -1**

Introduction, Development of Environmental Geotechnology, Aims, Environmental Cycle and their interaction with geotechnology, Natural environment, cycles of nature, environmental geotechnical problems. 8

**Unit -2**

Identification and characteristics of contaminated soil, classification, Characteristics of dust, dust in environment, ion-exchange reaction and ion exchange capacity, ion exchange reaction in contaminated soil-water system, Site Investigation for detection of sub-surface contamination 8

**Unit -3**

Load-environment factor design criteria, soil-structure vs structure soil interaction, load and environmental loads, Bearing capacity based on load footing interaction, lateral earth pressure, pile foundations, environmental factors affecting pile capacity, under-water foundation problems. 8

**Unit – 4**

Ash Pond and Mine Tailing Impoundments, Geotechnical re-use of waste materials and fills, Grouting and injection process, Grout used for controlling hazardous wastes, Sinkhole: interaction with environment , remedial action 8

**Unit -5**

Sanitary landfills: Selection of waste disposal sites, Landfills for Municipal and Hazardous wastes, Design of liners: clay and synthetic clay liners, Bearing capacity of foundation on sanitary landfills. 8

**Recommended Books:**

1. Fang, H. – Introduction to Environmental Geotechnology.
2. Sharma, H. D. and Sangeeta, P.L. - waste containment systems, waste stabilization and landfills: design and evaluation.
3. Koerner, R. M. - Designing with geosynthetics
4. Environmental & Geotechniques by Robert W. Sarsby
5. Geostatics for Environmental & geotechnical Publication Shahrukh Rouhanvy

**NCE – 034 Industrial Pollution Control and Environmental Audit**

L T P  
3 1 0

**Unit-1**

Industrial wastes & their sources: various industrial processes, sources and types of wastes-solid, liquid, gaseous, noise & radiation emissions. Sources for industrial water usages and various industrial

processes requiring water use and water quality. 8

**Unit-2**

Processes responsible for deterioration in water quality, Various waste water streams, Control and removal of specific pollutants in industrial wastewaters, e.g., oil and grease, bio-degradable organics, chemicals such as cyanide, fluoride, toxic organics, heavy metals, radioactivity etc. Wastewater re-uses & recycling, concept of zero discharge effluent. 8

**Unit-3**

Control of gaseous emissions: hood and ducts, tall stacks, particulate and gaseous pollutant control; Solid waste generation and disposal management; Hazardous wastes: definitions, concepts and management aspects; Noise & radiation: generation, control and management. 8

**Unit-4**

Recent trends in industrial waste management, cradle to grave concept, life cycle analysis, clean technologies; Case studies of various industries, e.g., dairy, fertilizer, distillery, sugar, pulp and paper, iron and steel, metal plating, thermal power plants, etc. 8

**Unit-5**

Environmental audit: definitions and concepts, environmental audit versus accounts audit, compliance audit, relevant methodologies, various pollution regulations, Introduction to ISO and ISO 14000. 8

**Recommended References:**

1. *Industrial Wastewater Management Handbook*, Azad, Hardom Singh, Editor-in-Chief, McGraw Hill, New York.
2. *Wastewater Reuse and Recycling Technology-Pollution Technology Review-72*, Culp, Gordan, George Wasner, Robert Williams and Mark , V.Hughes Jr., Noyes Data Corporation, New Jersey.
3. *The Treatment of Industrial wastes*. Edmund, B. Besselieve P.E., McGraw Hill, New York.
4. *Industrial Pollution Control –Issues and Techniques*. Nancy, J. Sell, Van Nostrand Reinhold Co, NY.
5. *Wastewater Engineering: Treatment & Re-use*. Metcalf & Eddy, Tata Mc Graw-Hill.
6. *Industrial Pollution Prevention Handbook*. Shen, T.T., Springer-Verlag, Berlin.
7. *Environmental Engineering*. Pandey, G.N. and Corney, G.C., Tata McGraw Hill, New Delhi
8. *Environment (protection) Act- 1986*. Any authorized & recent publication on Government Acts.
9. *Industrial Pollution Control and Environmental Audit* by Sanjay Gupta

**NCE-035 : Engineering Hydrology**

L T P  
3 1 0

**Unit-1**

Introduction: hydrologic cycle, water budget equations, world water balance, Precipitation: Forms of precipitation, measurement, depth-area-duration & intensity- duration- frequency relationships, probable maximum precipitation. 8

**Unit-2**

Abstraction from Precipitation: Evaporation – process, measurement and estimation; Evapo-transpiration-measurement and estimation; Initial Losses- Interception & Depression storage; Infiltration- process, capacities indices, measurement & estimation 8

**Unit-3**

Runoff and Hydrographs : Hydrograph, runoff characteristics of stream, Yield, Rainfall-runoff correlations, flow duration curve, mass curve, droughts and floods. Factors affecting flood hydrographs, unit hydrograph and its analysis, s-curve hydrograph, synthetic and instantaneous unit hydrographs. 8

**Unit-4**

Flood: Rational method, empirical formulae, unit hydrograph method, flood frequency studies, statistical analysis, regional flood frequency analysis, design storm & design flood, risk/reliability and safety factor; Flood Routing: Basic equation, hydrologic storage routing & attenuation, hydrologic channel routing, flood forecasting & control, hydraulic method of flood routing. 8

**Unit-5**

Groundwater: introduction, forms of subsurface water, aquifers & its properties, Compressibility of aquifers, flow equations for confined and unconfined aquifers, well hydraulics- steady and unsteady flow to a well in confined aquifer, well losses, specific capacity, ground water irrigation, rain water harvesting.

8

**Recommended Books:**

- *'Hydrology for Engineers'* by Linsley R. K., Kohler M. A. and Paulhus J. L. H.
- *'Engineering Hydrology'* by K. Subramanya, Mc Graw Hill Education
- *'Hydrology: Principles. Analysis. Design'* by Raghunath H. M.
- *'Handbook of Applied Hydrology'* by Chow V. T. , Mc Graw Hill Education
- *'Irrigation: Theory & Practice'* by Michael A. M.
- *'Engineering Hydrology'* by Ojha, Oxford University Press.
- *'Introduction to Hydrology'* by Viessman & Lewis by Pearson Publication.
- *'Applied Hydrology'* by Fetter, by Pearson Publication.

## NCE- 041 Precast and Modular Construction Practices

L T P  
3 1 0

### Unit – 1

Overview of reinforced and prestressed concrete construction Design and detailing of recast / prefabricated building components, 8

### Unit – 2

Structural design and detailing of joints in prefabricated structures, Production of ready mixed concrete, quality assurance, 8

### Unit – 3

Use of equipments in precast prefabricated structure, Productivity analysis, Economics of form work, Design of Formwork and their reusability, 8

### Unit – 4

Modular construction Practices, Fibonacci series, its handling and other reliable proportioning concepts.8

### Unit – 5

Modular coordination, Standardisation, system building, Lamination and Advantages of modular construction. 8

### Books :

1. Handbook of low cost housing by A K Lal
2. Precast Concrete Structures by Kim Elliot

## NCE – 042 Plastic Analysis of Structures

L T P  
3 1 0

### Unit - 1

Introduction, Historical review, plastic failure, plastic moment, capacity of a cross-section, shape factor, concept of load factor. 8

### Unit – 2

Plastic hinge and collapse Mechanisms. Analysis of beams and frames. 8

### Unit – 3

Semi Graphical method and Mechanism method. 8

### Unit – 4

Plastic moment distribution for multi-storey and multi-bay frames. 8

### Unit – 5

Analysis for deflections at collapse. Effect of axial force and shear. 8

### Books :

1. Plastic Analysis of Structures by P G Hodge, McGraw Hill
2. Plastic Analysis and Design of steel structures by M Bill Wong
3. Inelastic Analysis of Structures by M Jirasek & Z P Bazant , John Wiley

## NCE- 043 : Open Channel Flow

L T P  
3 1 0

### Unit – I

**Introduction:** Basic concepts of free surface flows, velocity and pressure distribution, Mass, energy and momentum principle for prismatic and non-prismatic channels, Review of Uniform flow: Standard equations, hydraulically efficient channel sections, compound sections,

Energy-depth relations: Concept of specific energy, specific force, critical flow, critical depth, hydraulic exponents, and channel transitions. 8

### Unit – II

**Gradually Varied Flow (GVF):** Equation of gradually varied flow and its limitations, flow classification and surface profiles, Control sections,

Computation methods and analysis: Integration of varied flow equation by analytical, graphical and advanced numerical methods, Transitions of subcritical and supercritical flow, flow in curved channels.

8

### Unit – III

**Rapidly Varied Flow (RVF):** Characteristics of rapidly varied flow, Classical hydraulic jump, Evaluation of the jump elements in rectangular and non-rectangular channels on horizontal and sloping beds, Hydraulic jump in gradually and suddenly expanding channels, submerged hydraulic jump, rolling and sky jump, use of jump as an energy dissipater,

8

**Flow measurement:** by sharp crested and broad crested weirs, critical depth flumes, sluice gate, Free overfall.

**Rapidly varied unsteady flow:** Equation of motion for unsteady flow, “Celerity” of the gravity wave, deep and shallow water waves, open channel positive and negative surge,

8

### Unit-IV

**Spatially Varied Flow (SVF):** Basic principles, Differential SVF equations for increasing and decreasing discharge, Classifications and solutions, Numerical methods for profile computation, Flow over side-weir and Bottom-rack.

8

### Unit – V

Flow in channel of non-linear alignment and non-prismatic channel sections, Design considerations for sub critical and super critical flows, Design of culvert.

8

### References:

1. Chow, V.T., Open channel Hydraulics, McGraw Hill International
2. Henderson, F.M., Open Channel Flow, McGraw Hill International
3. Subramanya, K., Flow in Open Channels, Tata McGraw Hill
4. Ranga Raju, K.G., Flow through open channels, T.M.H.
5. M. Hanif Chaudhry, Open Channel Flow, PHI
6. French, R.H., Open channel Hydraulics, McGraw Hill International
7. Srivastava, Flow through Open Channels, Oxford University Press.
8. Open Channel Flow by Madan Mohan Das

## NCE 044 - Tunnel Engineering

L T P  
3 1 0

### Unit – 1

Site investigations , Geotechnical Considerations of tunneling

8

### Unit – 2

Design of Tunnels

8

### Unit – 3

Construction & Excavation methods , soft ground tunnels , Rock tunnels

8

### Unit-4

Micro tunneling techniques , Tunnel support design

8

### Unit – 5

Ventilation of tunnels , tunnel utilities , safety aspects

8

### Books :

1. Tunnel Engineering Handbook by J O Bickel & T R Kuesel
2. Rock Mechanics Design in Mining & Tunneling by Z T Bieniawski
3. Harbour & Dock & Tunnel by R. Srinivasan
4. Tunnel Engineering by S.C. Saxena

## **NCE – 051 COMPUTER AIDED DESIGN**

L T P  
3 1 0

### **UNIT – 1**

Elements of Computer Aided Design and its advantages over conventional design. Hardware required for CAD works. 8

### **UNIT – 2**

Principles of software design, concept of modular programming, debugging and testing. 8

### **UNIT – 3**

Computer applications in analysis and design of Civil Engineering systems. 8

### **UNIT - 4**

Use of software packages in the area of Structural, Geotechnical, and Environmental fields. 8

### **UNIT – 5**

Expert system, their development and applications, Introduction to Neural Networks. 8

### **Reference:**

1. Computer Aided Design – S. Rajiv, Narosa Publication
2. A.I. and Expert System – Robert L. Lertine & / Lane E. Drang, McGraw Hill
3. “Neural Computing: Wasserman, vonnostrand.
4. Auto Cadd 2013 Dummies Bill Fane
5. Cad Frame & Architecture by Pieter Van Der Wolf

## **NCE – 052 ANALYSIS AND DESIGN OF HYDRAULIC STRUCTURES**

L T P  
3 1 0

### **UNIT – I**

Types of Head works: Component parts of a diversion headwork, Failure of hydraulic structures founded on permeable foundations, Principles of design, Bligh’s theory, Khosla’s theory for determination of pressure and exit gradient.

Regulation Works: Falls, Classification, Introduction to design principle of falls, Design of Sarda type and straight glacis fall.

Principle and design of Distributory head regulator and cross regulator, canal escape, Bed bars. 8

### **UNIT – II**

Canal head works: Functions, Location, Layout of head works. Weir and Barrage, Canal head Regulator, Introduction to the design principles of Weirs on permeable foundations, Design of vertical drop and sloping glacis weir.

Cross drainage works: Necessity and types. Aqueduct, Siphon Aqueduct, super passage, canal siphon, level crossing, Introduction to design principles of cross drainage works. 8

### **UNIT – III**

Flood routing: Types, methods of reservoir routing, channel routing by Muskingham Method.

Investigation and planning of dams and Reservoirs: Zones of storage, Estimation of storage capacity, Reservoir losses, Reservoir sedimentation and its control, life of a reservoir. Dams: classification and selection criteria.

Earth Dams: Classification, causes of failure Phreatic line, and its determination Introduction to stability analysis. 8

### **UNIT – IV:**

Gravity dams: Forces method of analysis, modes of failure and factor of safety, Elementary profile, stability analysis, galleries, joints, control of cracks. 8

### **UNIT – V**

Spillways: Spillway capacity, types of spillways, Design of ogee spillway, Energy dissipation below spillway, Design criteria for Hydraulic Jump type stilling basins with horizontal and sloping aprons, spillway gates.

Hydro-Electric Power: assessment of potential specially in reference to India, classification of



power plants, important terms, types of turbines and their suitability. Power House layout and important structures of a powerhouse. 8

#### **Text Books**

1. Water Resources Engg. By Larry W Mays, John Wiley India
2. Water resources Engg. By Wurbs and James, John Wiley India
3. Water Resources Engg. By R.K. Linsley, McGraw Hill
4. Irrigation and Water Resources Engg. By G L Asawa, New age International Publishers

#### **References**

5. Irrigation Engg. And Hydraulic Structures by S. K. Garg, Khanna Publishers
6. Irrigation and Water Power Engineering by B. C. Punimia & Pande B.B. Lal

### **NCE 053 WATER RESOURCES SYSTEMS**

L T P  
3 1 0

#### **Unit –I**

**Concept of System & System Analysis:** Definition and types of a system, System Approach and analysis, Basic Problems in System Analysis. 8

#### **Unit-II**

**System Techniques in Water Resources:** Optimization using calculus, Linear programming, Dynamic programming and Simulation, Combination of Simulation and Optimization. 8

#### **Unit-III**

**Economic Considerations in Water Resources Systems:** Basics of Engineering Economics, Economic Analysis, Conditions of project optimality, Benefit-cost Analysis 8

#### **Unit- IV**

**Multi-objective Planning:** Non-inferior solutions, Plan Formulation & Plan Selection. 8

#### **Unit V**

**Applications of Linear Programming:** Irrigation water allocation for single and multiple crops, Multi-reservoir system for irrigation Planning, Reservoir operation for Irrigation and Hydro-power Optimization

**Application of Dynamic Programming:** Optimal crop water allocation, Steady State, Reservoir Operation policy for Irrigation. 8

#### **Books Recommended:**

1. Ossenbruggen, P. J. – System Analysis for Civil Engineering, John Wiley, New York
2. Taha, H. –Operational Research-An Introduction, V<sup>th</sup> Edn, Prentice Hall.
3. Loucks, D. P., Stedinger, and Haith, D. A. – Water Resources Systems Planning & Analysis, Prentice Hall.
4. Jain, S. K. and Singh, V. P. – Water Resources Systems Planning & Management, Elsevier, Amsterdam
5. Water Resource System by Subhash Chander & Rajesh k Prasad
6. Water Resource System by PR Bhave

### **NCE 054 Machine Foundation Design**

L T P  
3 1 0

#### **Unit -1**

Vibration of elementary Systems: Vibration motion, vector representation of harmonic motion, Single degree of freedom system: Free Vibrations- damped and undamped, Forced Vibrations – damped and undamped. 8

#### **Unit -2**

Dynamics of soil-foundation System: types of machine foundation, design criteria, dynamic loads, physical modeling and response analysis, Barken's approach, Ford & Haddow's analysis, Hammer foundation, I. S. Codes. 8

#### **Unit -3**

Dynamic soil testing techniques: cyclic plate load test, block vibration test, shear modulus test, geophysical methods, Resonance-column test, Two & three borehole techniques, Model tests using centrifuge and shake table, recent developments 8

#### **Unit – 4**

Vibration isolation and control: vibration transmitted through soil media, active and passive isolation, vibration isolation – rigid foundation and flexible foundation, method of isolation, properties of material and media used for isolation, vibration control of existing machine, foundation isolation by barriers. 8

#### **Unit -5**

Guidelines for design and construction of machine foundation: data required for design of reciprocating, impact and rotary type machines, guidelines for the design of different type machines, construction guidelines, guidelines for providing vibration absorbers. 8

#### **Books:**

1. S. Prakash – Machine Foundation .
2. B. B. Prasad – Fundamentals of Ground Vibration
3. Richard, Hall and Wood – Vibrations of Soil and Foundations
4. Foundation for Industrial Machine by R.G. Bhatia

## NCE 061 Ground Improvement Techniques

L T P  
3 1 0

### Unit -1

Introduction, Review of compaction theory, effect of compaction on surface behaviour, Field methods of compaction, Quality Control, Design of soil-lime, soil-cement, soil-bitumen and soil-lime-flyash mixes. 8

### Unit -2

In-situ densification methods in granular soils, Deep compaction: Introduction, Terra-Probe, Vibroflotation techniques, Ground Suitability for Vibroflotation, Advantages, Mueller Resonance Compaction, Dynamic Compaction, Depth of Improvement. 8

### Unit -3

In-situ densification methods in cohesive soil: Introduction, Pre-loading and de-watering, Vertical drains, Electrical method, Thermal method. 8

### Unit – 4

Grouting: introduction, suspension grout, solution grout, grouting equipments and methods, Grouting design and layout

Granular Piles: Ultimate bearing capacity and settlement, method of construction, load test. 8

### Unit -5

Underpinning of foundations: importance and situations for underpinning, methodology, typical examples.

Geotextiles: types, functions, specifications, precautions in transportation and storage. 8

### Recommended Books:

1. S. K. Garg – Soil Mechanics & Foundation Engineering.
2. Purshotham Raju – Ground Improvement.
3. Gopal Ranjan and A. S. R. Rao – Basic and Applied Soil Mechanics
4. J. N. Mandal – Geosynthetics World
5. Bergado et. al. – Soft Ground Improvement
6. Koerner, R. M. - Designing with geosynthetics
7. Ground Improvement Techniques by Dr. P Purushothama Raj

## NCE 062 RIVER ENGINEERING

L T P  
3 1 0

### Unit – I

Introduction, classification of Rivers, Mechanics of alluvial rivers including channel and flood plain features, Sediment transport and budgets, River morphology and various classification schemes. 8

### Unit –II

Behaviour of Rivers: Introduction, River Channel patterns, Straight river channels, causes, characteristics and shapes of meanders and control, cutoff, Braided Rivers, Bed forms, Instability of rivers, Hydraulic geometry, Delta formation and control. 8

### Unit-III

Mechanics of Alluvial Rivers, Rivers and restoration structures, Socio-cultural influences and ethics of stream restoration. 8

### Unit-IV

Bio-engineering Techniques, Classification review, Natural Channel Design Analysis, Time Series, Analysis of flow, Sediment and channel geometry data. 8

### Unit-V

River Training and Protection Works: Introduction, Classification of River Training, Types of training works, Protection for Bridges with reduced waterway, Design of Guide Band, embankment and spurs/dampners and other river/ flood protection works. 8

### Textbook:

1. River Behaviour Management and Training (Vol. I & II), CBI&P, New Delhi.
2. Irrigation & Water Power Engineering- B. C. Punmia and Pande B. B. Lal.
3. River Engineering by Margeret Peterson

4. Principles of River Engineering by ( the non tidal alluvial) PH Jameen

**NCE-063: Groundwater Management**

L T P  
3 1 0

**Unit-1**

Introduction, hydrological cycle & definitions, Occurrence of ground water, hydro-geology & aquifers, Ground water movement, Darcy's law, flow-nets in isotropic medium. 8

**Unit-2**

Steady and unsteady flow through confined and unconfined aquifers, Dupuits theory, Observation wells, Well Hydraulics: Single & Multiple well system, partially penetrating wells, Image wells, Mutual interference of wells, well losses, specific capacity, Inverse problem i.e. pumping tests for aquifer parameters, 8

**Unit-3**

Water Wells: Design of water wells, Well construction, Well completion, Development of wells Pumping equipment for water wells, maintenance of wells, ground water irrigation. 8

**Unit-4**

Ground Water quality, Contamination of groundwater and its Control, Ground Water Modeling Techniques, Ground water exploration, Surface and Subsurface Investigations of Ground water, Artificial discharge and Recharge of Ground Water, Groundwater drainage, 8

**Unit-5**

Ground Water Management Techniques: Groundwater budgeting, groundwater modeling & stimulation, application of GIS and remote sensing in groundwater management. roof-top rainwater harvesting and recharge. 8

**Recommended References:**

- 'Groundwater Hydrology' by Todd D. K.
- 'Groundwater Resource Evaluation' by Walton W. C.
- 'Groundwater' by Raghunath H. M.
- 'Handbook of Applied Hydrology' by Chow V. T.
- 'Irrigation: Theory & Practice' by Michael A. M.
- 'Groundwater' by S.Ramakrishnan

**NCE – 064 EARTHQUAKE RESISTANT DESIGN**

L T P  
3 1 0

**Unit – 1**

Internal structure of earth, Causes of earthquakes, Seismic waves, Magnitude, Intensity and Energy released, Characteristics of Earthquakes, 8

**Unit - 2**

Response of Structure to Earthquake motion, Modeling of structures, Dynamics of single degree of freedom system, 8

**Unit -3**

Dynamics of multi degree of freedom system, Idealization of structures, seismic response, 8

**Unit – 4**

Introduction to earthquake resistant design, Equivalent lateral force method, Response spectrum method, Time history method, Introduction to earthquake resistant brick and masonry buildings. 8

**Unit – 5**

Reinforced Concrete framed buildings, Code provisions. Introduction to machine foundation & its design. Degrees of freedom of a block foundation. 8

**References:**

1. Introduction to Structural Dynamics - J.M. Biggs

2. Elements of Earthquake Engineering - Jai Krishna an A.R. Chandrasekaran
3. IS: 1983 - 1984 Criterion for Earthquake Resistant Design.
4. Structural Dynamics - Theory & computation - Mario Paz.
5. Dynamics of Structures Theory and Applications to Earthquake Engineering - Anil K. Chopra.
6. Earthquake Resistant of Design of structures, Agarwal and Srikhande.
7. Earthquake Resistant of Design of structures, S.K.Duggal

**OPEN ELECTIVES- I**  
**NOE-071: ENTREPRENEURSHIP DEVELOPMENT**

**L T P**  
**3 1 0**

**UNIT -I**

**Entrepreneurship-** definition. growth of small scale industries in developing countries and their positions vis-a-vis large industries; role of small scale industries in the national economy; characteristics and types of small scale industries; demand based and resources based ancillaries

and sub-control types. **5**

Government policy for small scale industry; stages in starting a small scale industry. **2**

**UNIT -II**

**Project identification-** assessment of viability, formulation, evaluation, financing, field-study and collection of information, preparation of project report, demand analysis, material balance and output methods, benefit cost analysis, discounted cash flow, internal rate of return and net present value methods. **8**

**UNIT -III**

**Accountancy-** Preparation of balance sheets and assessment of economic viability, decision making, expected costs, planning and production control, quality control, marketing, industrial relations, sales and purchases, advertisement, wages and incentive, inventory control, preparation

of financial reports, accounts and stores studies. **9**

**UNIT -IV**

**Project Planning and control:**

The financial functions, cost of capital approach in project planning and control. Economic evaluation, risk analysis, capital expenditures, policies and practices in public enterprises. profit planning and programming, planning cash flow, capital expenditure and operations. control of financial flows, control and communication. **9**

**UNIT -V**

Laws concerning entrepreneur viz, partnership laws, business ownership, sales and income taxes

and workman compensation act. **5**

Role of various national and state agencies which render assistance to small scale industries. **2**

**Text / Reference Books:**

1. Forbat, John, "Entrepreneurship" New Age International.
2. Havinal, Veerbhadrappa, "Management and Entrepreneurship" New Age International
3. Joseph, L. Massod, "Essential of Management", Prentice Hall of India.

**NOE-072: QUALITY MANAGEMENT**

**L T P**  
**3 1 0**

**UNIT-I**

**Quality Concepts:**

Evolution of Quality Control, concept change, TQM Modern concept, Quality concept in design, Review of design, Evolution of proto type. **3**

### **Control on Purchased Product**

Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure. **2**

### **Manufacturing Quality**

Methods and techniques for manufacture, inspection and control of product, quality in sales and services, guarantee, analysis of claims. **5**

### **UNIT-II**

#### **Quality Management**

Organization structure and design, quality function, decentralization, designing and fitting, organization for different type products and company, economics of quality value and contribution, quality cost, optimizing quality cost, seduction program. **3**

#### **Human Factor in quality**

Attitude of top management, cooperation of groups, operators attitude, responsibility, causes of apparatus error and corrective methods. **2**

### **UNIT-III Control**

#### **Charts**

Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts. **5**

#### **Attributes of Control Chart**

Defects, construction and analysis of charts, improvement by control chart, variable sample size, construction and analysis of C charts. **5**

### **UNIT -IV**

Defects diagnosis and prevention defect study, identification and analysis of defects, correcting measure, factors affecting reliability, MTTF, calculation of reliability, building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle. **8**

### **UNIT –V**

ISO-9000 and its concept of Quality Management

ISO 9000 series, Taguchi method, JIT in some details. **7**

### **Text / Reference Books:**

1. Lt. Gen. H. Lal, "Total Quality Management", Eastern Limited, 1990.
2. Greg Bounds, "Beyond Total Quality Management", McGraw Hill, 1994.
3. Menon, H.G, "TQM in New Product manufacturing", McGraw Hill 1992.

### **NOE-073: OPERATIONS RESEARACH**

**L T P**

**3 1 0**

### **UNIT-I**

#### **Introduction:**

Difinition and scope of operations research (OR), OR model, solving the OR model, art of modelling, phases of OR study.

#### **Linear Programming:**

Two variable Linear Programaming model and Graphical method of solution, Simplex method, Dual Simplex method, special cases of Linear Programming, duality, sensitivity analysis.

### **UNIT-II**

#### **Transportation Problems:**

Types of transportation problems, mathematical models, transportation algorithms,

**Assignment:**

Allocation and assignment problems and models, processing of job through machines.

**UNIT-III**

**Network Techniques:**

Shortest path model, minimum spanning Tree Problem, Max-Flow problem and Min-cost problem.

**Project Management:**

Phases of project management, guidelines for network construction, CPM and PERT.

**UNIT-IV**

**Theory of Games :**

Rectangular games, Minimax theorem, graphical solution of 2 x n or m x 2 games, game with mixed strategies, reduction to linear programming model.

**Quality Systems:**

Elements of Queuing model, generalized poisson queuing model, single server models.

**UNIT-V Inventory**

**Control:**

Models of inventory, operation of inventory system, quantity discount.

**Replacement:**

Replacement models: Equipments that deteriorate with time, equipments that fail with time.

**Text / Reference Books:**

1. Wayne L. Winston, "Operations Research" Thomson Learning, 2003.
2. Hamdy H. Taha, "Operations Research-An Introduction" Pearson Education, 2003.
3. R. Panneer Seevam, "Operations Research" PHI Learning, 2008.
4. V.K.Khanna, "Total Quality Management" New Age International, 2008.

**NOE-074: INTRODUCTION TO BIOTECHNOLOGY**

**L T P**  
**3 1 0**

**UNIT-I**

**Introduction:** Concept nature and scope of biotechnology.

**Cell Structure and Function:** Eukaryotic and prokaryotic cells, cell wall, membrane organization, cell organelles, Nucleus, Mitochondria, endoplasmic reticulum, chloroplast, viruses and toxins into cells.

**Cell Division:** Mitosis and Meiosis.

**8**

**UNIT-II**

**Biomolecules:** A brief account of structure of carbohydrates, Lipids and Proteins.

**Genes:** Brief idea about Mendel's laws and chromosomes, nature of genetic materials, DN A and RNA, DNA replication.

**7**

**UNIT-III**

**Gene Expression:** Central dogma, genetic code, molecular mechanism on mutations, regulations of gene expression, house keeping genes, differentiation and development mutations and their molecular basic.

**Genetic Engineering:** Introduction, cloning (vectors and enzymes), DNA and genomic libraries, Transgenics, DNA fingerprinting, genomics.

**9**

**UNIT-IV**

**Applications of Biotechnology:** Bioprocess and fermentation technology, cell culture, Enzyme



technology, biological fuel generation, sewage treatment, environmental biotechnology, biotechnology and medicine, biotechnology in agriculture, food and beverage technology, production of biological invention. **9**

**UNIT-V**

**Safety and Ethics:** Safety, social, moral and ethic considerations, environmental ethics, bioethics and stem cell research, safety of new biotechnology foods, agro biodiversity and donor policies. **7**

**Text Books/ Reference Books:**

1. Smith, "Biotechnology" Cambridge Press.
2. P.K. Gupta, "Elements of Biotechnology" Rastogi
3. H. D. Kumar, "Modern concepts of Biotechnology" Vikas publishing House.

## OPEN ELECTIVES- II

### NOE-081: NON-CONVENTIONAL ENERGY RESOURCES

L T P  
3 1 0

#### UNIT-I

##### Introduction

Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. **3**

##### Solar Cells:

Theory of solar cells. solar cell materials, solar cell array, solar cell power plant, limitations. **4**

#### UNIT-II

##### Solar Thermal Energy:

Solar radiation, flat plate collectors and their materials, applications and performance, focussing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations. **9**

#### UNIT-III Geothermal

##### Energy:

Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations. **4**

##### Magneto-hydrodynamics (MHD):

Principle of working of MHD Power plant, performance and limitations. **2**

##### Fuel Cells:

Principle of working of various types of fuel cells and their working, performance and limitations. **3**

#### UNIT-IV

##### Thermo-electrical and thermionic Conversions:

Principle of working, performance and limitations. **2**

##### Wind Energy:

Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. performance and limitations of energy conversion systems. **6**

#### UNIT-V

##### Bio-mass:

Availability of bio-mass and its conversion theory. **2**

##### Ocean Thermal Energy Conversion (OTEC):

Availability, theory and working principle, performance and limitations.

##### Wave and Tidal Wave:

Principle of working, performance and limitations.

Waste Recycling Plants. **3**

##### Text/References Books:

1. Raja etal, "Introduction to Non-Conventional Energy Resources" Scitech Publications.
2. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006.
3. M.V.R. Koteswara Rao, " Energy Resources: Conventional & Non-Conventional " BSP Publications,2006.
4. D.S. Chauhan,"Non-conventional Energy Resources" New Age International.
5. C.S. Solanki, "Renewal Energy Technologies: A Practical Guide for Beginners" PHI Learning.

6. Peter Auer, "Advances in Energy System and Technology". Vol. 1 & II Edited by Academic Press.

## NOE-82: NON-LINEAR DYNAMIC SYSTEMS

**L T P**  
**3 1 0**

### **UNIT-I**

#### **Dynamic systems:**

Concept of dynamic systems, importance of non-linearity, nonlinear dynamics of flows (in 1, 2, and 3 dimensions) and Maps (1 and 2 dimensions) in phase space, Equilibrium, Periodicity.

Picard's theorem, Peano's theorem, boundedness of solutions, omega limit points of bounded trajectories. **8**

### **UNIT-II**

#### **STABILITY-I:**

Stability via Lyapunov's indirect method, converse Lyapunov functions, sublevel sets of Lyapunow functions, Lasalle's invariance principle. **7**

### **UNIT-III**

#### **Stability-II**

Lyapunov's direct method, converse Lyapunov's theorems, Brokett's theorem, applications to control system, stable manifold theorem, centre manifold theorem, normal form theory and applications to nonlinear systems. **8**

### **UNIT-IV**

#### **Bifurcation:**

Elementary Bifurcation theory, catastrophe, strange attractor, fractals, fractal geometry and fractal dimension. **8**

### **UNIT-V**

#### **Chaos:**

Deterministic Chaos, routes to chaos (period doubling, quasiperiodicity, intermittency, universality, renormalization); Measurement of Chaos (Poincare section, Lyapunov index, entropy); control of chaos. **9**

#### **Reference Books:**

1. D.K. Arrowsmith and C.M. Place, "An Introduction to Dynamical Systems" Cambridge University press, London, 1990.
2. K.T. Alligood, T.D. Sauer, and J.A Yorke, "CHAOS: An Introduction to Dynamical System" Springer Verlag, 1997.
3. H.K. Khalis, "Nonlinear Systems" Prentice Hall, 1996.
4. R. R. Mohler, "Non linear systems, Vol-I: Dynamics and Control" Prentice Hall, 1991.
5. J.M. T. Thomson and H.B. Stewart, "Nonlinear Dynamics and Chaos" John Wiley & Sons, 1986.
6. Stanislaw H. Zak, "Systems and control" Oxford University Press, 2003.

## NOE- 083: PRODUCT DEVELOPMENT

L T P  
3 1 0

### UNIT-1

Concept of Product, definition and scope.

Design definitions, old and new design methods, design by evolution, examples such as evolution of sewing M/C, bicycle, safety razor etc., need based developments, technology based developments physical reliability & economic feasibility of design concepts.

### UNIT –II

Morphology of design, divergent, transformation and convergent phases of product design, identification of need, Analysis of need. Design criteria; functional, aesthetics, ergonomics, form, shape, size, colour.

Mental blocks, Removal blocs, Ideation techniques, Creativity, Check list.

### UNIT –III

Transformations, Brainstorming & Syntetics, Morphological techniques.

Utility Concept, Utility Value, Utility Index, Decision making under Multiple Criteria.

Economic aspects, Fixed and variable costs, Break-even analysis.

### UNIT-IV

Reliability considerations, Bath tub curve, Reliability of systems in series and parallel, Failure rate, MTTF and MTBF, Optimum spares from Reliability considerations.

Design of display and controls, Man- machine interface, Compatibility of displays and controls. Ergonomic aspects, Anthropometric data and its importance in design.

Application of Computers in Product development & design.

### UNIT-V

Existing techniques, such as work-study, SQC etc. for improving method & quality of product.

Innovation versus Invention. Technological Forecasting.

Use of Standards for Design.

### Text/Reference Books:

3. A.K. Chitab & R.C. Gupta "Product design & Manufacturing" – Prentice Hall (EE)
4. R.P. Crewford, "The Technology of creation Thinking" Prentice Hall.
5. C.D. Cain, "Product Design & Decision" Business Books.
7. C.D. Cain, "Engg. Product Design" Business Books.

## NOE-084: AUTOMATION AND ROBOTICS

L T P  
3 1 0

1. **Introduction:** Definition, Classification of Robots, geometric classification and control classification.
2. **Robot Elements:** Drive system, control system, sensors, end effectors, gripper actuators and gripper design.
3. **Robot Coordinate Systems and Manipulator Kinematics:** Robot co-ordinate system representation, transformation, homogenous transform and its inverse, relating the robot to its world.  
Manipulators Kinematics, parameters of links and joints, kinematic chains, dynamics of kinematic chains, trajectory planning and control, advanced techniques of kinematics and dynamics of mechanical systems, parallel actuated and closed loop manipulators.

4. **Robot Control:** Fundamental principles, classification, position, path velocity and force control systems, computed torque control, adaptive control, Servo system for robot control,

and introduction to robot vision.

5. **Robot Programming:** Level of robot programming, language based programming, task level programming, robot programming synthesis, robot programming for welding, machine tools, material handling, assembly operations, collision free motion planning.

6. **Applications:** Application of robot in welding, machine tools, material handling, assembly operations parts sorting and parts inspection.

**Text/Reference Books:**

1. Coifet Chirroza, "An Introduction to Robot Technology" Kogan Page.
2. Y. Koren "Robotics for Engineers" McGraw Hill.
3. K. S. Fu, R.C. Gonzalez Y& CSG Lee, "Robotics" McGraw Hill.
4. J.J. Craig, "Robotics" Addison-Wesley.
5. Grover, Mitchell Weiss, Nagel Octrey, "Industrial Robots" McGraw Hill.
6. Asfahl, "Robots & Manufacturing Automation" Wiley Eastern.