Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Syllabus for

Final Year B. Tech.

Civil Engineering (Pattern 2017)

Department of Civil Engineering

Vision:

Excellence in Civil Engineering Education

Mission:

M1: Make competent Civil Engineers with high level of professional, moral and ethical values

M2: Impart highest standards in theoretical as well as practical knowledge and skill set

M3: Establish Center of Excellence in major areas of Civil Engineering to respond to the current and future needs of the industry, higher studies as well as research

PROGRAM EDUCATIONAL OBJECTIVES

PEO 1: Graduates will have successful career in the field of Civil Engineering

PEO 2: Graduates will respond to growing demands of society through professional and ethical practices

PEO 3: Graduates will pursue lifelong learning including higher studies in the field of Civil Engineering

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO1: Engineering graduates will be able to plan and execute the activities of construction projects

PSO2: Engineering graduates will be able to analyze and design components of Civil Engineering Systems.

FINAL YEAR B. TECH (CIVIL ENGINEERING), SEMESTER VII (PATTERN 2017)
MODULE-I

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
CVUA40171	Quantity Surveying, Contracts and Tenders*	TH	3	-	2	20	30	20	30	25	125	4
CVUA40172	Design of Structures – II*	TH	3	-	2	20	30	20	30	25	125	4
CVUA40173	Transportation Engineering	TH	3	-	2	20	30	20	30	25	125	4
CVUA40174	Elective-III	TH	3	-	2	20	30	20	30	25	125	4
CVUA40175	Intellectual Property Rights	CE	2	-	-	-	-	50	-	-	50	2
CVUA40176	Project Work*	CE-PR/OR	-	-	10	100	-	-	-	50	150	5
A4	Audit Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	14	-	18	180	120	130	120	150	700	23

***Course has Oral Examination**

Elective – III:

1. CVUA40174A: Dams and Hydraulic Structures
2. CVUA40174B: Business Analytics

List of Audit Courses: Professional Ethics; Cyber Security; Value Engineering and Human Rights; Legislative Procedures; Technical Writing/Documentation; Sports/Yoga; Performing Art such as music, dance, and drama etc.; Languages; Online certification course (minimum two weeks); Participation in intercollegiate co-curricular and extra-curricular activities.

BoS Chairman | Dean Academics | Director

FINAL YEAR B. TECH (COMMON TO ALL PROGRAMS), SEMESTER VII (PATTERN 2017)

MODULE II

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
CVUA40177	Semester Internship*	CE-PR/OR	-	-	24	100	-	-	-	50	150	12
A4	Audit Corse	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	24	100	-	-	-	50	150	12

*** Course has Oral Examination**

List of Audit Courses: Professional Ethics; Cyber Security; Value Engineering and Human Rights; Legislative Procedures; Technical Writing/Documentation; Sports/Yoga; Performing Art such as music, dance, and drama etc.; Languages; Online certification course (minimum two weeks); Participation in intercollegiate co-curricular and extra-curricular activities.

BoS Chairman | Dean Academics | Director

FINAL YEAR B. TECH (COMMON TO ALL PROGRAMS), SEMESTER VIII (PATTERN 2017) MODULE III

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credit
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
CVUA42171	Elective-IV*	TH	3	-	2	20	30	20	30	25	125	4
IOEUA42172	Open Elective-I	TH	2	-	2	20	30	20	30	25	125	3
IOEUA42173	Open Elective-II	TH	3	-	-	20	30	20	30	-	100	3
CVUA42174	Introduction to Research	CE	1	-	2	-	-	-	-	25	25	2
A4	Audit course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	9	-	6	60	90	60	90	75	375	12

***Course has Oral Examination**

List of Audit Courses: Professional Ethics; Cyber Security; Value Engineering and Human Rights; Legislative Procedures; Technical Writing/Documentation; Sports/Yoga; Performing Art such as music, dance, and drama etc.; Languages; Online certification course (minimum two weeks); Participation in intercollegiate co-curricular and extra-curricular activities.

Elective-IV		**Open Elective-I**		**Open Elective-II**	
CVUA42171A	Air Pollution and Control	IOEUA42172A	Introduction to Gaming	IOEUA42173A	Financial Technology
CVUA42171B	Advanced Surveying	IOEUA42172B	Inferential Statistics for Data Science	IOEUA42173B	Agriculture Electronics
		IOEUA42172C	Solar and Wind Energy	IOEUA42173C	Operation Research
CVUA42171C	Structural Dynamics and Earthquake Engineering	IOEUA42172D	Numerical Methods in Engineering	IOEUA42173D	Total Quality Management
		IOEUA42172E	Social Media Analytics	IOEUA42173E	Blockchain Technology

BoS Chairman

Dean Academics

Director

FINAL YEAR B. TECH (COMMON TO ALL PROGRAMS), SEMESTER VII (PATTERN 2017)

MODULE IV

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
CVUA40177	Semester Internship*	CE-PR/OR	-	-	24	100	-	-	-	50	150	12
A4	Audit Corse	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	24	100	-	-	-	50	150	12

***Course has Oral Examination**

List of Audit Courses: Professional Ethics; Cyber Security; Value Engineering and Human Rights; Legislative Procedures; Technical Writing/Documentation; Sports/Yoga; Performing Art such as music, dance, and drama etc.; Languages; Online certification course (minimum two weeks); Participation in intercollegiate co-curricular and extra-curricular activities.

BoS Chairman Dean Academics Director

FINAL YEAR B. TECH (CIVIL ENGINEERING), SEMESTER VIII
(PATTERN 2017)
MODULE-V

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/ OR/ TW		
CVUA40171	Quantity Surveying, Contracts and Tenders*	TH	3	-	2	20	30	20	30	25	125	4
CVUA40172	Design of Structures – II*	TH	3	-	2	20	30	20	30	25	125	4
CVUA40173	Transportation Engineering	TH	3	-	2	20	30	20	30	25	125	4
CVUA40174	Elective-III	TH	3	-	2	20	30	20	30	25	125	4
CVUA40175	Intellectual Property Rights	CE	2	-	-	-	-	50	-	-	50	2
CVUA40176	Project Work*	CE-PR/OR	-	-	10	100	-	-	-	50	150	5
A4	Audit Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	14	-	18	180	120	130	120	150	700	23

***Course has Oral Examination**

Elective – III:

1. CVUA40174A: Dams and Hydraulic Structures
2. CVUA40174B: Business Analytics

List of Audit Courses: Professional Ethics; Cyber Security; Value Engineering and Human Rights; Legislative Procedures; Technical Writing/Documentation; Sports/Yoga; Performing Art such as music, dance, and drama etc.; Languages; Online certification course (minimum two weeks); Participation in intercollegiate co-curricular and extra-curricular activities.

NOTE:

Students who will register for Module-I in Semester VII have to register either of Module-III or Module-IV in Semester VIII.

Students who will register for Module-II in Semester VII have to register for Module-V in Semester VIII.

BoS Chairman Dean Academics Director

MODULE I & V

Quantity Surveying, Contracts and Tenders (CVUA40171)

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	-	125

Course Objective(s):

- To make the students aware of types of estimates, its rates and valuation of a project.
- To introduce Tendering & Contracting procedures.

Course Outcomes:

Upon completion of the course, students will be able to

1. Explain types of estimates and its related terms and prepare an approximate estimate of civil engineering projects.
2. Prepare a detailed estimate of a framed structure building as per IS 1200 and load bearing structure using PWD & Centre Line Methods.
3. Draft technical specifications for item of work to be performed for a civil engineering project and compute their respective cost rates
4. Explain valuation, types of values and prepare a valuation Report on O-1 Format by applying Rental Basis, Land & Building basis, Direct Comparison Method, Profit based method, Belting of Land, Development method of valuation
5. Explain tendering procedure
6. Draft objectives and conditions of Contracts and Explain role/importance of Arbitration.

Unit I: Introduction and Approximate Estimates:

Introduction to estimates and related terms: Definition of estimation and valuation. Significance (application) of the Course. Purpose of estimation. Type of estimates, data required for estimation as a pre- requisite. Meaning of an item of work and enlisting the items of work for different Civil Engineering projects. Units of measurement. Mode of measurement of building items/ works. Introduction to components of estimates: face sheet, abstract sheet (BOQ), measurement sheet, Rate Analysis, lead statement. Provisional sum& prime cost items, contingencies, work charge establishment, centage charges. Introduction to D. S. R.

Approximate Estimates: Meaning, purpose, methods of approximate estimation of building & other civil engineering projects like roads, irrigation/ water supply, sanitary engineering, electrical works. (Theory& Numerical).

Unit II–Taking out quantities &Detailed estimate

Detailed estimates: Factors to be considered while Preparing Detailed Estimate, Detailed estimate of R.C.C framed structures using IS 1200, Concept of Estimation of Load Bearing Structure (PWD & Centre Line Method).

Bar Bending Schedule: Preparing Bar Bending Schedule for all RCC members of building

Unit III: Specifications and Rate Analysis

Specifications: Meaning & purpose, types. Drafting detailed specifications for materials, quality, workmanship, method of execution, mode of measurement and payment for major items like, excavation, stone/ brick masonry, plastering, ceramic tile flooring, R.C.C. work.

Rate Analysis: Meaning and factors affecting rate of an item of work, materials, sundries, labour, tools & plant, overheads & profit. Task work or out turn, factors effecting task work. Working out Rate Analysis for the items mentioned in specifications above

Unit IV: Valuation

Valuation: Purpose of valuation. Meaning of price, cost, and value. Factors affecting Value.
Types of value: only Fair Market Value, Book Value, Salvage, Scrap Value, Distressed Value and Sentimental Value. Concept of free hold and lease hold property. Estimation versus valuation. Methods of depreciation & obsolescence, Sinking Fund, Years Purchase.
Methods of Valuation of Building: Rental Basis, Land & Building basis, Direct Comparison Method, Profit based method, Belting of Land, Development method

Unit V: Tendering and Execution of Works

Tenders: Definition. Methods of inviting tenders, tender notice, tendering procedure, Pre and post qualification of contractors, tender documents. 3 bid/ 2 bid or single bid system. Qualitative and quantitative evaluation of tenders. Comparative statement, Pre-bid conference, acceptance/ rejection of tenders. Various forms of BOT &Global Tendering, E-tendering.
Methods of Executing Works: PWD procedure of work execution, administrative approval, budget provision, technical sanction. Methods of execution of minor works in PWD: Piecework, Rate List, Daily Labour. Introduction to registration as a contractor in PWD.

Unit VI: Contracts and Arbitration

Contracts: Definition, objectives & essentials of a valid contract as per Indian Contract Act (1872), termination of contract. Types of contracts: only lump sum, item rate, cost plus. Conditions of contract: General and Specific conditions. Conditions regarding EM, SD, and time as an essence of contract, conditions for addition, alteration, extra items, testing of materials, defective work, subletting, etc. Defect liability period, liquidated damages, retention money, interim payment or running account bills, advance payment, secured advance, final bill.
Arbitration: Introduction to Arbitrations as per Indian Arbitration & Conciliation Act (1996) Meaning and need of arbitration, qualities, and powers of an Arbitrator

Term Work:

The following exercises should be prepared and submitted:

1. Report on contents, use of current DSR & Drafting detailed specification for major items of works.
2. Working out quantities using C-L and PWD method for a small single storied load bearing structure up to plinth and Preparing Abstract Sheet using DSR(Regional)
3. Detailed Estimate of a single storied R.C.C framed building using D.S.R.
4. Working out quantities of steel reinforcement for a column footing, a column, a beam and a slab by preparing bar bending schedule.
5. Working out rate analysis for the items as in the specifications of Assignment No. 1.
6. Preparing Valuation of a Residential building and writing report using O-1 form
7. Estimating quantities for any one of the following using appropriate software. a) A Factory Shed of Steel Frame b) Underground Water Tank c) Pipe Culvert d) Road / Railway Track/ Runway
8. Drafting of tender notice, Preparation of Schedule A & B and Conditions of Contract regarding time, labour payment, damages for RCC Framed Structure (Assignment No. 3) and collecting minimum of 3 tender notices of Civil Engineering Works.

Oral Examination: Based on the Term Work.

Textbooks:

1. Estimating and Costing in Civil Engineering: Theory and Practice: B.N Dutta - S. Dutta & Company, Lucknow.
2. Estimating and Costing: R. C. Rangwala - Charotar Publ. House, Anand.
3. Estimating, Costing Specifications & valuation in Civil Engineering: M. Chakraborty
4. B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974

Reference Books:

1. Theory and Practice of Valuation: Dr. Roshan Namavati, Lakhani Publications.
2. Valuation Principles and Procedures: Ashok Nain, Dewpoint Publ.
3. Laws for Engineers: Dr. Vandana Bhat and Priyanka Vyas –Published by PRO-CARE,5/B,/Sagarika Society, Juhu Tara Road, Juhu, Santacruz(W),Mumbai-400049 procure@technolegal.org).

Handbooks:

1. Standard Contract Clauses for Domestic Bidding Contracts: Ministry of Statistics and Program Implementation, Government of India.
2. FIDIC Document: Federation International Des Ingenieurs Conseils i.e. International Federation of Consulting Civil Engineers, Geneva, Switzerland.
3. Indian Practical Civil Engineers 'Handbook: P. N. Khanna, UBS Publish. Distributor, Pvt. Ltd. (UBSDP).

Codes:

1. IS 1200 (Part 1 to 25): Methods of Measurement of Building & Civil Engg.Works.
2. IS 3861-1966: Method of Measurement of Areas and Cubical Contents of buildings.
3. D. S. R. (District Schedule of Rates) for current year.
4. PWD Redbooks, Vol 1 & 2.

e – Resources: nptel.iitm.ac.in

Design of Structure II (CVUA40172)

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	-	125

Prerequisites: Strength of Materials, Analysis of structures

Course Objective(s): The course will help

- To develop the ability to understand the behavior and basic concepts in design of various members of reinforced concrete structures subjected to combination of different loads based on provisions of Indian Standard code, and the prestressed concrete, prestress losses and to evaluate the resultant stress in prestressed concrete section.

Course Outcomes:

Upon completion of the course, students will be able to

1. **Understand** the composite action of reinforced concrete, design philosophies and **explain** the behavior of reinforced concrete section under flexure.
2. **Analyze** and **design** singly, doubly and flanged reinforced concrete section subjected to flexure using Limit State Method as per guidelines given in Indian Standard Code.
3. **Analyze** and **design** reinforced concrete section subjected to shear, torsion and bond using Limit State Method as per guidelines given in Indian Standard Code.
4. **Design** one way and two way reinforced concrete slabs and dog legged staircase using Limit State Method as per guidelines given in Indian Standard Code.
5. **Design** reinforced concrete short column and isolated column footing subjected to gravity loads using Limit State Method as per guidelines given in Indian Standard Code.
6. **Understand** basic concepts, prestressing systems, applications, prestress losses of prestressed concrete section and **calculate** the resultant stress in prestressed concrete section subjected to flexure using stress concept at transfer of prestressing force and at service condition.
7. **Demonstrate** the ability to develop structural drawings for R.C.C. framed structure using modern engineering tools individually and / or through teamwork.

Unit I: Introduction to reinforced concrete (RC) and limit state method

a. Introduction to R. C. (composite action). Role of structural designer, Structural properties of concrete and steel. Behaviour of concrete under compression (stress-strain curve) and tension, and steel under tension. Design philosophies. Concept of transformed section, singly and doubly R. C. sections.

b. Classification of limit states. Characteristic strengths and loads. Partial safety factors. Analysis of R.C. section under flexure – assumptions, strain and stress variation across the section. Behaviour of R.C. section under flexure (under reinforced, Balanced and over reinforced sections). Design parameters for rectangular R.C. section, Moment of resistance of rectangular under reinforced singly, doubly and flanged R. C. section.

Unit II– Design for flexure using LSM

a. Loads and load combinations. Stability of a structure and code provisions (Actions on a structure, failure behaviour and safety). Limit state of serviceability: IS code recommendation for limit state of deflection, cracking and fire.
b. Design for flexure: Design of rectangular under reinforced singly, doubly and flanged RC section using LSM.

Unit III: Design for shear, torsion and bond

a) Modes of cracking. Shear transfer mechanism. Shear failure modes. Nominal shear stress. Critical sections for shear design. Shear resistance of RC section. Design of RC section subjected to shear as per Indian Standard Code.
b) Behaviour of RC member under torsion. Torsional shear stress. Need for torsional reinforcement. Indian Standard Code provisions for design RC member subjected to torsion. Concept and types of bond. Bond development mechanism. Bond failure mechanism. Check for adequacy of bond as per Indian Standard Code requirements.

Unit IV: Design of slabs and staircases

a. Design and reinforcement detailing of one way slabs (Simply supported, cantilever and continuous) and dog legged staircase using Indian Standard code.
b. Design and reinforcement detailing of two way slabs using Indian Standard code. Distribution of slab load on beams.

Unit V: Design of column and column footing

a. Column: Introduction, Indian Standard code requirements for design and reinforcement detailing of short column. Design and reinforcement detailing of short column for axial load, uni-axial and bi- axial bending using interaction curves.
b. Isolated column footing: Soil pressure distribution under isolated footing. General design considerations for isolated footing slab for flexure, shear, bearing and bond. Design and reinforcement detailing of isolated column footing using Indian Standard code.

Unit VI: Introduction to prestressed concrete

a. Basic concept and general principle of prestressed concrete. Materials used in prestressed concrete. Need for high strength materials. Prestressing systems. Advantages, disadvantages and application of prestressed concrete.
b. Concepts of prestressing: Stress, strength, load balancing. Resultant stress at a prestressed concrete section flexure at transfer of prestressing force and at service condition. Introduction to loss of prestress. Total permissible losses. Methods to reduce prestress losses.

Term Work:

1. Design G + 1 (2 bay 2 storied) RC building covering all types Slabs, Beams, Columns, Footings and Staircase.
2. Design of all plinth and ground beams.
3. Design of all slabs, beams of first floor.
4. Design of three types columns for, (a) axial load, (b)axial load + uniaxial BM, (c)axial load +biaxial BM), from terrace level to footing. Give detailed load calculations.
5. Design any one element using spreadsheet / any software.
6. Report on one Site Visit (Building under construction).

Note:

a. Complete the practical work in a group with maximum number of students per group limiting to four.
b. Reinforcement details should be developed as per SP - 34.
c. Reinforcement details should be drawn using any drafting software (e.g. AutoCAD).
d. Develop minimum four full imperial size sheets showing details of structural plan at plinth, first floor and terrace level, reinforcement details of slabs, beams, staircases, column and column footing

Textbooks:

1. Reinforced Concrete Design, S. Pillai and Devdas Menon, Tata McGraw Hill, New Delhi.
2. Comprehensive Design of R.C. Structures, Punmia, Jain and Jain, Standard Book House, New Delhi.
3. Reinforced Concrete Volume II, Dr. H. J. Shah. Charotar Publishing House Pvt. Limited.
4. Prestressed Concrete- N. Krishna Raju – Tata Mc Graw Hill Publication Co.

Reference Books:

1. Illustrated Design of Reinforced Concrete Buildings (G+3), Dr. V. L. Shah and Dr. S.R.
2. Karve, Structures Publications, Pune. Illustrated Reinforced Concrete Design, Dr. V. L. Shah and Dr. S.R. Karve, Structures Publications, Pune.
3. Design of Prestressed concrete structures - T. Y. Lin, John Wiley Publishers.

Reference codes and standards:

1. IS: 456-2000: Plain and Reinforced Concrete – Code of Practice, BIS, New Delhi.
2. SP 34 – Handbook on Concrete Reinforcement and detailing
3. SP 16 – Design Aids for Reinforced concrete to IS 456:1980 Code Book.
4. IS 1343:2012 – Prestressed Concrete– Code of Practice, BIS, New Delhi.

Transportation Engineering (CVUA40173)

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Course Objective(s):

1. To provide broad awareness to the students to deal with traffic issues including safety, planning, design, operation and control.
2. To provide basic knowledge about aviation system and its functions with plan and design basic airport facilities such as runways, taxiways, etc.
3. To provide basic knowledge about bridge component its function, classification and types and erection techniques.

Course Outcomes:

Upon completion of the course, students will be able to

1. Explain the fundamentals of highway planning, development and Design highway geometrics
2. Understand the traffic parameters of a highway and Determine the properties of highway materials as per IS, IRC, MORTH to design the mix for rigid and flexible pavement
3. Understand the design steps of pavement as per IRC 37 and IRC 58
4. Explain the types of pavement construction and modern trends in highway engineering
5. Understand about airport planning with layout, use of wind rose diagram and determine the runway length
6. Understand about bridge engineering, bridge types, bridge components and Determine the discharge, economical span, afflux

Unit I -Highway Development & Planning and its Geometric design:

History, Development Plans, Classification of roads, Road Patterns, road development in India - Vision 2021 & Rural Road Development Vision 2025, Current road projects in India; highway alignment and highway project report preparation (Planning surveys & Master Plans based on saturation system).Highway cross section elements; sight distance, design of horizontal alignment; design of vertical alignment; design of intersections, problems, Highway drainage, Importance of highway drainage, subsurface and surface drainage systems.

Unit II–Traffic engineering and Pavement materials:

Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control devices (signs, signals, islands, road markings); Accident studies, types of road intersections; parking studies; highway lighting.

Materials used in Highway Construction and related tests - Soil subgrade and CBR Test, Stone aggregates, bituminous binders, bituminous paving mixes, viscosity based gradation of bitumen, Modified Bitumen (Cutbacks, Emulsions, Crumbed Rubber Modified Bitumen – CRMB, Polymer Modified Bitumen-PMB, Foamed Bitumen), Marshall Stability Mix Design and Test (All 5 test parameters).

Unit III- Pavement Design
Introduction; flexible pavements – Computation of design traffic (Vehicle Damage Factor VDF, Lane distribution factor LDF, Traffic growth rate); stresses in flexible pavements; design guidelines for flexible pavements as per IRC 37-2012 (steps only); rigid pavements- components and functions; factors affecting design; stresses in rigid pavements (ESWL); design guidelines for concrete pavements as per IRC 58-2015 (steps only); joints in CC pavements, problems during Construction
Unit IV- Pavement Construction
A. Pavement Construction: Construction process of GSB, WBM, WMM; Cemented base, Introduction to bituminous works such as prime coat, tack coat, seal coat, Built-up Spray Grout (BSG), Asphaltic Concrete (AC) or Bituminous Concrete (BC), Bituminous Macadam (BM), Dense Bituminous Macadam (DBM) and premix carpet, Dry lean Concrete (DLC), Pavement Quality Concrete (PQC). **B. Modern Trends in Highway Materials, Construction & Maintenance:** Mastic Asphalt, Cold Mix Asphalt Technology, Warm Mix Asphalt Technology, Recycled/Reclaimed Asphalt Pavement (RAP) (Manual Series - 2), Concept of Super pave Mix Design (Super pave Series 2), Non-Destructive Evaluation of Pavements (Falling Weight Deflectometer FWD).
Unit V - Airport Engineering
Introduction: Advantages and limitations of air transportation. Aeroplane component parts and important technical terms. **Airport planning and Airport layout:** Aircraft characteristics, which influence judicious and scientific planning of airports, Selection of sites, survey and drawings to be prepared for airport planning. Characteristics of good layout, runway configuration, airport obstruction, location of terminal buildings, aprons and hangers. Zoning requirements regarding permissible heights of constructions and landing within the airport boundary. **Runways and taxiways:** Runway orientation, wind coverage, use of wind rose diagram, basic runway length, corrections for elevation, temperature and gradient as per ICAO and FAA recommendation. Airport classification by ICAO.
Unit VI - Bridge engineering
Introduction: Classification of bridges, components of bridges, preliminary data to be collected during investigation of site for bridges, determination of discharge – empirical formula, direct methods, economical span, afflux, HFL, scour depth and clearance, locations of piers and abutments, factors influencing the choice of bridge super structure, approach roads. **Loads on bridges and substructure:** Brief specifications of different loads, forces, stresses coming on bridges, IRC load specification, requirements of traffic in the design of highway bridges, Abutment, Piers, and wing walls with their types based on requirement and suitability. **Types of bridges:** Culvert, Temporary bridges: timber, floating and pantoon bridges, Movable Bridges: Bascule, cut boat, flying, swing, lift, transporter and transverse bridges, their requirement and suitability, Fixed span bridges: Simple, continuous, cantilever, arch, suspension, bowstring girder type and rigid frame and cable stayed bridges, materials for super structure. **Bearing:** Definition, purpose and importance. Types of bearings with their suitability. **Erection of bridge super structure and maintenance:** Introduction to different techniques of erection of bridge super structure and maintenance of bridges
Term Work:
A. List of Practical: **I. Tests on Aggregate (Any Five):**

1. Aggregate Impact and Crushing Value Test
2. Los Angeles Abrasion Test
3. Shape Test (Flakiness Index and Elongation Index)
4. Specific Gravity and Water Absorption Test by basket method
5. Stripping Value Test
6. Soundness Test

II. Tests on Bitumen (Any Five + No. 8 compulsory):

1. Penetration Test
2. Ductility Test
3. Viscosity Test
4. Softening Point Test
5. Flash Point & Fire Point Test
6. Specific Gravity Test
7. Bitumen Extraction Test
8. Marshall Stability Test

B. Technical visits to 1) Bridge site/Airport and 2) Hot mix Plant with detailed report

Textbooks:

1. Principles of Highway Engineering and Traffic Analysis (4th edition) - F. L. Mannering, Scott S. Washburn, Wiley India
2. Highway engineering – S.K. Khanna and C.E.G. Justo, Nem Chand and Brothers, Roorkee
3. Principles and practices of Highway engineering –Dr. L.R. Kadiyali, Khanna
4. Essentials of Bridge Engineering – D. Johnson and Victor, Oxford and IBH publishing
5. Co. Pvt. Ltd. , New Delhi.
6. Bridge engineering – S. Ponnuswamy, Tata Mc Graw – Hill publishing co. Ltd. New Delhi.
7. Airport planning and design – S.K. Khanna , M.G. Arora , S.S. Jain, Nem Chand and Brothers, Roorkee.
8. Airport Engineering - Rangawala, Charotar publishing House, Anand 388001 (Gujrat)

Reference Books:

1. A Course in Highway Engineering – S.P. Bindra, Dhanpat Rai and Sons, Delhi.
2. Principles of Transportation Engineering – G.V. Rao Tata MacGraw Hill Publication
3. Highway Engineering – Rangawala, Charotar publishing House, Anand 388001 (Gujrat)
4. Principles of Transportation Engineering – Partha Chakraborty ,Animesh Das, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Highway and Bridge Engineering – B.L. Gupta, Amit Gupta Standard publishers Distributors, Delhi.
6. Principles and practice of Bridge Engineering – S.P. Bindra, Dhanpatrai and Sons, Delhi.
7. Bridge engineering – Rangawala, Charotar Publishing House, Anand –388 001.

Handbooks:

1. Handbook of Road Technology- Lay M.G., Gorden Breach Science Pub. New york
2. Civil Engineering Handbook-Khanna S.K.

Codes:

1. I.S. 1201 TO 1220-1978, IS 73, IS 2386 PART I to V
2. I.R.C. 58, IRC37
3. Specifications for Road and Bridge works (MORTH)-IRC, New Delhi.
4. ICAO manual of Airport

e – Resources:
1. www.nptel.iitm.ac.in/courses/iitkanpur 2. www.cdeep.iitb.ac.in/nptel 3. www.fhwa.dot

ELECTIVE-III
Dams and Hydraulic Structures (CVUA40174A)

Teaching Scheme	**Examination Scheme**						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Course Objective(s):

(1) To make the students aware of types of dams, spillways, canals and their suitability along with their hydraulic design

(2) To give students clarity about the hydraulic structures allied to the dams as well as canals along with their suitability and hydraulic design

Course Outcomes:

Upon completion of the course, students will be able to

1. Classify dams based on purpose, hydraulic action, structural action, materials, size of project and Explain working of instrumentation, equipment for dam safety, socio-economic problems associated with construction of large dams, terms related to layout of hydropower generation
2. Explain components of Gravity dams with forces acting on it and perform its stability analysis.
3. Classify Spillways and Spillway gates based on operation, provision of gates, main features, function, mechanism of gates respectively and Design Ogee spillway along with Energy dissipator.
4. Classify Earth dams based on materials, its methods of construction, components and Check stability of homogeneous, non- homogeneous earthen dams.
5. Describe functions of components of diversion roadworks, cross- drainage works and Analyze flow below weir in permeable foundation using Khosla's Theory.
6. Design of lined Canals on Alluvial beds by Kennedy's, Lacey's theory and Explain working and necessity of canal structures, river training works

Unit I: Introduction

Review of basic concepts from fluid mechanics, Need & historical development of dams, important terms related to dams, Classification of dams: Based on purpose, hydraulic action, structural action, materials, and size of project. Factors governing the selection of type of dam, Selection of site for a dam, Environmental and socio-economic issues related to large dams and small dams. Displacement and rehabilitation, Dams and climate change. Overview of the instrumentation and equipment for various measurements related to dam safety. hydropower generation: Necessity, Important Terms related to Hydropower, layouts.

Unit-II: Gravity Dams

Introduction, Components of gravity dam, Forces acting on gravity dam, Seismic analysis of dam, Terms related to seismic analysis, Determination of Seismic forces, Effects of horizontal and vertical earthquake acceleration, Combinations of loading for design, Stress analysis in gravity dam (Only concept, no derivations), Vertical or normal stress, Principal stresses, Shear stress, Middle third rule, Modes of failure of gravity dam, Elementary profile of gravity dam, Concepts of low and high gravity dams

Unit-III: Spillways and Gates for Dams

Introduction, Need and location of spillway, Different key levels (heads) of spillway, Components of spillway: Approach channel, Control structure, Discharge channel, Energy dissipation device, Tail channel. Classification of spillways: Based on operation, based on provision of gates, based on main features (Straight drop spillway, Free overflow spillway, Saddle spillway, Side channel spillway, Ogee spillway, Chute or open channel or trough spillway, Shaft or morning glory spillway, Siphon spillway, Conduit or tunnel spillway, Stepped spillway. Design of Ogee spillway: shape of the crest, spillway profile on upstream and downstream. Energy dissipation below spillway (Through buckets, Solid roller bucket, Slotted roller bucket, Ski jump bucket), Correlation between Jump Height and Tail Water Depth, Classification of energy dissipation devices, Energy dissipation in stilling basin, Stilling basin components, Indian Standard stilling basins. Spillway gates: Classification – Based on function, Based on mechanism of gates. Requirements inspection and maintenance of spillway gates

Unit-IV: Earth Dams

Classification of earth dam, Classification based on---materials, method of construction, height; Selection of type of earth dam, Limitations of earth dam, Components of an earth dam, Requirements for safe design of earth dam, Hydraulic (Seepage) Analysis, Plotting of seepage line and determination of seepage discharge for Homogeneous earth dam with horizontal drainage blanket, Composite earth dam with casing and hearting, Properties of phreatic line, Determination of seepage discharge through earth dam using flow-net, Stability analysis of homogeneous and zoned earth dam, using Swedish slip circle method, Fellenius Method of Locating Centre of Critical Slip circle, Failure of earth dam, Types of failure of earth dams: Hydraulic, Seepage failure, Structural failure, Other failures. Causes of seepage and seepage control, Construction of earth dam.

Unit-V: Diversion Headworks and C.D. Works

Diversion headworks: Functions, Selection of site, typical layout, and components. Analysis of weir on permeable foundation using , Khosla's theory. Exit gradient and design criteria of weirs on permeable foundations. Cross-Drainage Works: Necessity, Selection of site, Data required for design, Classification (Drain over canal – Siphon, Super passage, Canal over drain – Aqueduct, Siphon aqueduct, Drain and Canal at the same level – Level crossing, Inlet and Outlet).Suitable type of C. D. Work. Design considerations for C. D. Work.

Unit-VI: Canals, Canal Structures and river training works

Classification of canals: Based on alignment, Based on soil, Based on source of supply, Based on discharge, Based on lining, and Based on excavation. Components of canal, Data required for canal design, Selection of canal alignment, Design of stable canal in alluvial beds. Kennedy's theory and its limitations. Design of canal based on Kennedy's theory, Lacey's regime theory, Design of canal based on Lacey's theory, Canal lining: Need, requirements of lining material, Classification, advantages and limitations of canal lining, Design of lined canal, Overview of canal structures – Canal Regulator, Canal Falls, Canal Outlets, and Canal Escape: Necessity, typical layout, types/ classification with suitability, pros and cons. Introduction to river training works: Necessity, Types and Suitability.

Term Work:

Term Work consists of parts A, B, C and D.

Part (A): Analysis /Design Assignments (Any three): *Each exercise is to be completed in the allotted Lab. Hence requires two practical sessions each.*

1) Stability analysis of gravity dam
2) Design of Ogee of spillway and energy dissipation device below the spillway

3) Stability analysis of earthen dam
4) Analysis of weirs on permeable foundations
5) Design of lined and unlined canal

Part (B): Any two site visits (Out of the following and individual reports with photographs)

1) Gravity dam
2) Earthen dam
3) C.D. Work
4) Canal structure

Note: *Visit report should clearly mention Name of project, date of visit, need and practical significance of project, its salient features, technical details, description and figures of different components, special features, and photographs at the site wherever allowed.*

Textbooks:

(1) Irrigation, Water Resources and Water Power Engineering- Modi, P.N. - Standard Book House, New Delhi, 7th e, 2008.
(2) Irrigation Engineering and Hydraulic Structures- S. K. Garg - Khanna Publishers N.D. 29th e, 2014.
(3) Irrigation Engineering and Hydraulic Structures- S. R. Sahasrabudhe- S. K. Kararia& Sons (Katson Books), 3rd e, 2011.

Reference Books:

(1) Irrigation Engineering- R. K. Sharma –S. Chand, 2007.
(2) Irrigation Engineering- N.N. Basak–Tata McGraw Hill, 1999.
(3) Irrigation and Water Resources Engineering- G. L. Asawa - New Age International (P) Ltd. Publishers, 1st e, 2005.

ELECTIVE-III
Business Analytics (CVUA40174B)

Teaching Scheme	**Examination Scheme**						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Course Objective(s):

1. To study the fundamentals of Business Analytics
2. To study of powerful visualizations, reports and dashboards
3. To understand the process of data export and import in Power BI tool
4. To learn the process of Customized calculation writings with the help of tool
5. To understand the deployment of reports and dashboards for user consumption.

Course Outcomes:

Upon completion of the course, students will be able to

1. Understand the importance of analytics and need of data preparation for analytics.
2. Understand and evaluate the different components of analytics landscape and project cycle aligned with these components.
3. Implement and evaluate different data transformation, data modelling steps and visualize the data on the data models
4. Implement and evaluate the ways of adding custom calculations needed and understand the applications of different statistical concepts.
5. Understand, implement and evaluate the deployment, administration cycle of analytics implementations using Power BI
6. Understand, evaluate various topics and concepts in the areas of analytics and also the industrial applications through study of different use cases.

Unit-I: Need of Analytics and Data Preparation

Introduction to Analytics: What is Analytics? Need of Analytics Why Microsoft Power BI? Types of Business Analytics

Data Sources: Data Collection, Transactions Entry, Organizational Systems, Data Sources and Data Source Categories, Issues in Data and Need of Data Preparation

Need of Data Preparations: What is Data Preparation? Joining data, Appending Data, New Calculations, Removing Inconsistencies, Transposing

Setting up Power BI: Installation and configuration of Power BI Desktop, Setup of required connector

Unit II: Data Landscape and Project Cycle

Understanding Data and Databases: What is a database? What is a DBMS? What is SQL? What are tables? Organization of tables in databases, Types of Data, Database Keys, Relationships between tables, Joins and Unions, Cross-database Joins, Type of Data: Structured, Unstructured and Semi-structured data

Data Architecture: BI Architecture, Data Security and Governance, Administration

Analytics Project Lifecycle: Requirements Understanding, Data Understanding, Wireframes, Data Preparation, Data Visualization, Deployment, Documenting, Project Team and Roles, Challenges in Projects.

Unit III: Data Modelling And Visualization

Data Integration and Data Warehouses: What is Data Integration? Need of Data Integration, ETL, What is Data Warehouse? Need of Data Warehouse, Facts and Dimensions Star Schema and Snowflake Schema, Data Marts

Data Transformation [Basics]: Merging and Appending Data, Filtering, Cleaning Data, Fixing Errors, Transforming Data, Aggregating Data,

Data Modelling: Setting Relationships, Creating Data Models

Data Visualization: What are KPIs? Dashboards, Reports and Scorecards, Types of Dashboards, Slicers and Filters, Setting interactivity, Creating Hierarchies, Groups, Drilldowns and Drill-through, Formatting your visualizations, Best practices of visualizations, Aggregations: SUM, MAX, AVG, MIN

Unit IV: Custom Calculations And Analytics

Data Transformations [Advanced]: Tabular Model at database level, Cross-database joins

Calculations: Calculated Fields, Calculated Measures, Time-intelligent Functions, Moving Averages and Running Total, What-if Analysis, Conditional formatting

Statistical Analytics: Mean, Mode, Median, Variance and Standard Deviation, Simple Regression, Multiple Regression.

Unit V: Power Bi Deployment, Administration And Mobility

Power BI Deployment: Overview of Power BI Service, Publishing to Power BI Service, Understanding the Power BI Service Workspaces, Apps, Creating Dashboards in Power BI Service, Subscriptions, Comments and Data Driven Alerts, Authoring reports within Power BI Service, Sharing dashboards across your organization, Configuring Gateways, Scheduling automated refresh of your reports using Data Gateway

Power BI Advanced Features: Using NLP to creating dashboards, Influencers, Delivering Insights, Explain Analysis

Mobile Analytics: Creating Dashboards for Mobiles, Using dashboards and reports using Mobile App

Unit VI: Industry Analytics Landscape

Working with Tableau: Introduction to Tableau, Installation and Setup of Tableau Desktop, Visualizing with Tableau

Advanced Concepts: Web Analytics, Sentiment Analysis, Big Data, Data Lakes, IoT

Applications of Business Analytics: Manufacturing Use Cases, EPC Use Cases, Retail Use Cases, Future Trends of Analytics

Term Work:

The following exercises should be prepared and submitted:

1. Creating multiple sample tables and joining them in Power BI
2. Connecting to data source and transforming data in Power BI
3. Connecting to data source and creating data models by establishing relationships
4. Connecting to data source and visualizing and analyzing data
5. Connecting to data source and creating custom calculations
6. Deploying the dashboards and reports to Power BI Service
7. Administering and using advanced features of Power BI Service
8. Creating Mobile layouts in Power BI Desktop

Reference Books:

1. "Business Intelligence Guidebook: From Data Integration To Analytics" by Rick Sherman, Elsevier Inc.
2. "Successful Business Intelligence, Second Edition: Unlock the Value Of BI & Big Data" by Cindi Howson, McGraw Hill Edition
3. "Data Analytics For Beginners: Your Ultimate Guide To Learn And Master Data Analysis. Get Your Business Intelligence Right – Accelerate Growth And Close More Sales" by Victor Finch
4. Data Strategy: How To Profit From A World Of Big Data, Analytics And The Internet Of Things" by Bernard Marr, Kogan page Publications, Auva Press
5. "Performance Dashboards – Measuring, Monitoring, And Managing Your Business" by Wayne Eckerson, John Wiley & Sons, Inc
6. "Business Intelligence Roadmap: The Complete Project Lifecycle For Decision Support
7. Applications" by Larissa T. Moss & Shaku Atre, Addison-Wesley information Technology Series
8. "Artificial Intelligence: Building Intelligent Systems" by Dr. Parag Kulkarni, Dr. Prachi Joshi,
9. PHI publication (for understanding of concepts)

Intellectual Property Rights (CVUA40175)

Teaching Scheme	**Examination Scheme**						
Credits: 2 Lecture (L): 2 hrs./week Tutorial (T): NA Practical (P): NA	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	-	-	50	-	-	-	50

Course Objective(s):

- **Explain** the importance of ideas, concept and creativity
- **Transfer** the knowledge about the IPR required for Engineer's
- **Describe** the how IPR creates National wealth
- **Teach** National and International IP System

Course Outcomes:

Upon completion of the course, students will be able to

1. Explain property and Intellectual property their nature, importance and objectives. (Understand)
2. Understand and Demonstrate types of IPR: Patents, Designs, Trademarks (Registered and unregistered trademarks), Copyright, Traditional Knowledge, Geographical Indications, Trade Secrets, Idea Patenting (Understand)
3. Understand the process of patenting, development and International scenario: WIPO, TRIPs (Understand)
4. Explain administration of patent system. (Understand)

Unit I:

Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives of understanding Intellectual Property Rights, IPR and IITs

Unit II–

Understanding the types of Intellectual Property Rights: - Patents, Designs, Trademarks (Registered and unregistered trademarks), Copyright, Traditional Knowledge, Geographical Indications, Trade Secrets, Idea Patenting, (Case Studies)

Unit III:

New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development, International Scenario: WIPO, TRIPs, Indian Patent Office and its Administration.

Unit IV:

Administration of Patent System – Patenting under Indian Patent Act, Patenting under PCT , Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non-Provisional Patent Application and Specification.

Textbooks:

1. Resisting Intellectual Property by Halbert, Taylor & Francis Ltd ,2007
2. Industrial Design by Mayall, Mc Graw Hill
3. Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley

Reference Books:

1. Intellectual Property Rights under WTO by T. Ramappa, S. Chand
2. Introduction to Design by Asimov, Prentice Hall

MODULE III

Elective IV
Air Pollution and Control (CVUA42171A)

Teaching Scheme	**Examination Scheme**						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	-	125

Course Objective(s):

To develop an ability to understand the classification of various air pollutants, their sources and effects on mankind, animals and structures, meteorological aspects, ambient air sampling methods, various methods to control air pollution; legislation, regulation and environmental impact assessment in India to control air pollution.

Course Outcomes:

Upon completion of the course, students will be able to

1. **Classify** air pollutants, their sources and effects on human beings, animals, materials, vegetation and global environment.
2. **Understand** meteorological aspects in civil engineering and calculate minimum and effective stack height as per CPCB.
3. **Explain** sites, methods, techniques, procedure, devises for sampling of gases and particulates and **understand** National Ambient Air Quality Standards (NAAQS) 2009.
4. **Understand** control of outdoor air pollution by natural processes, change in process, operation practices, use of equipments and indoor air pollution by cleansing systems.
5. **Explain** legislation and regulation in India to control air pollution.
6. **Understand** components, methods, processes, legislation of Environmental Impact Assessment and procedure, agencies involved with their role in environmental clearance in India

Unit I: Sources and Effects of Air Pollution

Classification of air pollutants-primary and secondary, natural and manmade, stationary and mobile, indoor and outdoor, particulates and gaseous pollutants. Sources of air pollution. Effects of air pollution on human beings – sick building syndrome, materials, vegetation, animals. Global effects-Green house effect, acid rain, ozone depletion, global warming. Photochemical smog. Economic effects.

Unit II: Meteorological aspects

Definition. Zones of atmosphere. Scales of meteorology. Meteorological parameters. Atmospheric stability. Dispersion of pollutants. Air pollution dispersion models-Gaussian dispersion model. Wind rose diagram. Inversions. Temperature inversion. Lapse rate. Mixing height. Plume behaviour. Plume rise. Determination of minimum stack height and effective stack height as per CPCB norms.

Unit III: Ambient Air Sampling and Monitoring

Basic consideration of air sampling. Sampling devices, sites and methods for sampling of gases and particulates. Stack sampling techniques. Isokinetic sampling. Procedure for particulate matter and gaseous sampling. Analysis of air samples- chemical and instrumental methods. Emission inventory. National Ambient Air Quality Standards (NAAQS) 2009.

Unit IV: Control of Air Pollution
Natural air controlling processes. Control at source. Control of air pollution by process changes-substitution of raw material, process modification, replacement of equipment, changes in operational practices. Control of particulate matter using equipment's – working principle, construction and operation, advantages and disadvantages of settling chamber, cyclones, fabric filters, Electrostatic precipitator, scrubbers. Control of gaseous pollutants. Control of indoor air pollutants and cleansing systems. Control of air pollution from automobiles.
Unit V: Legislation and Regulation in India
Land use planning. Economics of air pollution and control – Cost Benefit Ratio and optimization. Legislation and Regulation – Objectives, Penalties drawbacks of Air (Prevention and Control) Pollution Act 1981. The Environment (Protection) Act 1986. Functions of state and central boards. Emission standards for stationary and mobile sources.
Unit VI: Environmental Impact Assessment and Management
Need and objectives of Environmental Impact Assessment. EIA legislation in India. Components, process and methods of EIA. Public hearing. Environmental Management Plan. Environmental clearance (EC) procedure, Agencies involved and their role in obtaining environmental clearance for project. Environmental (Sitting for Industrial Projects) rules 1999.
Term Work:
One assignment based on each unit.
Textbooks:
1. Air Pollution – H. V. N. Rao and M. N. Rao, TMH, Pub. 2. Air pollution – KVSG Murali Krishna. 3. Air Pollution – Perkins. 4. Environmental Engineering – Davis, McGraw Hill- Pub.
Reference Books:
1. Air Pollution Control – Martin Crawford. 2. Air Pollution Control: its origin and control, K. Wark, C.F. Warner & W.T.Davis . 3. Fundamentals of Air Pollution-Richard W. and Donald L. Academic Press.

Elective IV
Advanced Surveying (CVUA42171B)

Teaching Scheme	**Examination Scheme**						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	-	125

Course Objective(s):

1. To understand principles of geodetic surveying, trigonometric levelling and theory of errors and adjustments
2. To understand the basic concepts of SBPS, remote sensing and GIS
3. To Understand photogrammetry concepts and fundamentals of Air photo Interpretation

Course Outcomes:

Upon completion of the course, students will be able to

1. **Explain** triangulation method for geodetic survey and **determine** intervisibility and elevation difference between triangulation stations using trigonometric levelling.
2. **Explain** fundamentals of geodesy and segments, positioning methods, and errors in Space Based Positioning System.
3. **Describe** concepts, physical fundamentals and components of Remote Sensing
4. **Describe** objectives, components, limitations and applications of Geographical Information System.
5. **Compute** most probable values of angles in triangulation, considering plane and spherical angles
6. **Describe** classification, applications, flight planning in aerial photogrammetry and **determine** scale & relief displacement in vertical photograph.

Unit I – Geodetic Survey & Trigonometric Levelling

a) Geodetic Survey - Objects, Methods of Geodetic Surveying, Introduction to Triangulation, classification of Triangulation Systems, Triangulation figures, Concept of well-conditioned Triangle, selection of stations, intervisibility and height of stations.

b) Trigonometric Levelling - Terrestrial refraction, Angular corrections for curvature and refraction, Axis Signal correction, Determination of Difference in Elevation by single observation and reciprocal observations.

Unit II: Geodesy & Satellite Based Positioning System

a) Geodesy - Definitions and fundamentals, Geoid and Ellipsoid of rotation, Reference surface, Geodetic systems, Indian Geodetic System, Coordinate systems and transformation.

Introduction to Satellite based positioning systems (SBPS), SBPS systems - GPS, Glonoss, Galileo, Navic, Compass, etc. and their features, Segments of SBPS (Space, Control and User), their importance and role in SBPS, Positioning with SBPS - Absolute & Differential Methods, Use of SBPS in Surveying, SBPS Co- ordinates & heights, Factors governing accuracy in SBPS positioning, Different types of errors in SBPS Positioning.

Unit III: Remote Sensing

Introduction and definition, development of remote sensing technology and advantages, different platforms of remote sensing, EM spectrum, solar reflection and thermal emission remote sensing, interaction of EM radiation with atmosphere including atmospheric scattering, absorption and emission; interaction mechanisms of EM radiation with ground, spectral response curves, principles of image interpretation, multi-spectral scanners and imaging devices, salient characteristics of LANDSAT, IRS, Cartosat, ResourceSat etc. sensors, image characteristics and different resolutions in Remote Sensing; manual and digital image interpretation techniques; Remote Sensing integration with GIS and GPS, Georeferencing Technique, spatial filtering techniques; Remote sensing for underground utility mapping; Image classification techniques, Hyperspectral Remote Sensing, applications of RS, Limitations of Remote Sensing Technique.

Unit IV: Geographical Information System

Introduction & definition, different components, types of vector data, Raster data models and their types, TIN data model; Advantages and disadvantages associated with vector, raster and TIN, Non-spatial data (attributes) and their type, Raster data compression techniques, Different raster data file formats, Spatial database systems and their types; Pre-processing of spatial datasets, Different map projections, Spatial interpolation techniques, Different types of resolutions, Digital Elevation Model (DEM); GIS analysis and applications, Errors in GIS, Key elements of maps

Unit V: Theory of Errors & Triangulation Adjustment

Kinds of errors, Laws of weights, Determination of most probable values (MPV) of conditioned and independent quantities, Method of Least Squares, Indirect observations, Probable error and its determination, Distribution of error to the field measurements, Normal equation, Method of correlates. Station and figure adjustment of Geodetic Quadrilateral without central station. Spherical triangle, Calculations of spherical excess and sides of spherical triangle.

Unit VI: Aerial Photogrammetry

Objects, Classification- qualitative & quantitative photogrammetry Applications, comparison of map and aerial photograph, Vertical, Tilted and Oblique photographs, Scale of & Relief displacement in vertical photograph, Stereoscopic parallax & its measurement by parallax bar. Mirror stereoscope, Differential height from differential parallax. Ground control points (GCPs), Flight planning.

Term Work:

Geodetic Surveying and Trigonometrical levelling (any three)

1. Measurement of horizontal and vertical angles with 1" theodolite.
2. Determination of elevation of inaccessible objects by trigonometrical levelling.
3. Practical based on various special functions available in a total station such as remote elevation measurements, remote distance measurements and co-ordinate stakeout.
4. Establishing control station using single or dual frequency GPS receiver

Aerial Photogrammetry (any two)

1. Study of aerial photograph and finding out the scale of the photograph.
2. Determination of air base distance using mirror stereoscope.
3. Determination of difference in elevation by parallax bar.

Remote Sensing

1. Study and applications of different RS data products available with National Remote Sensing Centre (NRSC)
2. Use of RS images and visual interpretation

GIS

1. Use of interface and tools in GIS software such as GRAM++ or QGIS or equivalent software.

Project: (Any one)

1. Adjustment of geodetic quadrilateral without central station by method of correlates.
2. Field survey (500 sq.m.) using GPS (Control as well as mapping).

Textbooks:

1. Surveying & Levelling, 2/E—Subramanian - Oxford University Press
2. Surveying: Vol. II. and III by Dr. B. C. Punmia : Laxmi Publication - New Delhi.
3. Surveying and Levelling Vol. II by T. P. Kanetkar and S. V. Kulkarni Pune Vidyarthi Publication.
4. GPS Satellite Surveying—Alfred Leick—Wiley
5. Remote sensing and Geographical Information System, By A. M. Chandra and S. K. Ghosh, Narosa Publishing House.
6. Remote Sensing & GIS,2/E—Bhatta-- Oxford University Press

Reference Books:

1. Principles of Geographical Information System—Burrough-- Oxford University Press
2. Surveying—M.D.Saikia—PHI Learning Pvt .Ltd.Delhi
3. Advanced Surveying -Total Station, GIS and Remote Sensing by SatheeshGopi, R.Sathikumar and N. Madhu , Pearson publication
4. Surveying Vol. 2 by S. K. Duggal, McGraw Hill Publication
5. Remote sensing & image interpretation, Lillesand& Kiefer, John wiley Pub.

Suggested Reading:

Bureau Gravimetrique International (BGI)
International GPS Service for Geodynamics (IGS)
International Association of Geodesy (IAG)
International Federation of Surveyors (FIG)
Permanent Service for Mean Sea Level (PSMSL)
Commission X Global and Regional Geodetic Networks
www.nrsa.gov.in
www.iirs-nrsa.gov.in
www.surveyofindia.gov.in

Elective IV
Structural Dynamics and Earthquake Engineering (CVUA42171C)

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	-	125

Prerequisite: Design of Reinforced Concrete buildings, Mechanics of structure I and Mechanics of Structures II.

Course Objective(s):

To prepare the students to apply the knowledge of Structural Dynamics in Earthquake Engineering

Course Outcomes:

Upon completion of the course, students will be able to

1) Determine the response of Single Degree of Freedom System under undamped- free and forced vibrations.
2) Determine the response of Single Degree of Freedom System under damped- free and forced vibrations.
3) Determine the response of Multi Degree of Freedom System under free undamped vibrations.
4) Comprehend the basics of seismology and seismic resistant structural systems.
5) Compute the base shear and lateral loads acting on regular RC buildings.
6) Draw the detailing of members of RC building for seismic resistance.

Unit I: Undamped SDOF Systems

Introduction to structural Dynamics, Basic Concepts of Vibration, Dynamic Loading, Comparison of Static Loading and Dynamic Loading, Types of Vibration, Response of the System, Degrees of Freedom, Simple Harmonic Motion.
Introduction to SDOF systems- Undamped Vibration of SDOF system, Natural Frequency, Period of Vibration, Damping in the structure, Newton's Laws of Motion, D-Alembert's Principle, Solution of Differential Equation of Motion, Amplitude of motion. Forced Vibration under Harmonic Excitation.

Unit II: Damped SDOF Systems

Viscous Damping, Equation of Motion, Critically-damped, Over-damped and Under-damped Systems, Solution of Differential Equation of Motion, Logarithmic Decrement, Forced Vibration under Harmonic Excitation. Response to Ground Motion.

Unit III: Multi Degree of Freedom System

Concept of Shear Building, mathematical Model, Equation of Motion, Free Vibration Analysis for Undamped System, Natural Frequency, Mode Shapes, Orthogonality Property of Normal Modes. (Maximum 3 degrees of freedom).

Unit IV: Introduction to Earthquake Engineering

Causes of Earthquake, Types of Earthquakes, Strong Ground Motion- Characteristics of the Strong Ground Motion, Factors affecting the Ground Motion, Seismic Zoning map of India, Earthquake Design Philosophy, Importance of Ductility in Earthquake Resistant Design, Structural Systems for Seismic Resistance- Moment Resisting Frames, Shear Wall Frame System and Tube System

Unit V: Computation of Seismic Forces on the Structures
Codal Provisions for Seismic Analysis as per IS 1893, General Principles, Load Combinations, Equivalent Static Method- Zone Factor, Importance factor, Response Reduction Factor, Approximate Period of Vibration, Design Response Spectrum, Estimation of Base Shear, Lateral Loads at Floor Level, Numerical Examples on Regular RC buildings.
Unit VI: Design and Detailing of RC Building Structure for Seismic Resistant
Ductility Criteria for earthquake Resistant Structure, General Design and Detailing Principles to ensure Ductility, Ductile Detailing of Flexural Members as per IS 13920- Longitudinal Reinforcement, Shear Reinforcement, Anchorage of Reinforcement and Concept of the Development Length, Lap Splices, Structural behavior of Shear Wall. Numerical Examples on Design of Beam and Column of RC portal Frame for given Loads and Load Combinations.
Term Work:
The Term Work will be based on the completion of assignments as shown below. 1 At least one assignment on each unit. 2 Analysis of R.C. Building (G+3) for Seismic Loads using any Software.
Textbooks:
1. Pankaj Agarwal and Manish Shrikhande, 'Earthquake Resistant Design of Structures', PHI, 2008 2. S. R. Damodarasamy and S. Kavitha- 'Basics of Structural Dynamics and Aseismic Design, PHI, 2009. 3. Mario Paz and William Leigh, 'Structural Dynamics-Theory of Computation', Kluwer Academic Publishers
Reference Books:
1. K. Chopra, Dynamics of Structures - Theory and Application to Earthquake Engineering, Prentice Hall 2. Clough R.W. and Penzien J., 'Dynamics of Structures', McGraw-Hill, 2nd edition, 1992

OPEN ELECTIVE – I
Introduction to Gaming (IOEUA42172A)

Teaching Scheme	Examination Scheme						
Credits: 3 Lecture (L): 2 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Course Objective(s):

1. To learn about the video game art principles, Video Game production, Design Process and the Industry
2. To understand and distinguish Video game elements, genres, types ad hardware
3. To Study various video game production practices, terminology, Industry roles and responsibilities
4. To know the application and use of a game engine across various verticals and develop and learn how to work with the game engine as a tool for production
5. To examine and game engine interface, coding, game objects, asset Store, services, etc

Course Outcomes:

Upon completion of the course, students will be able to

1) Use terminology related to Games and Interactive Media Industry
2) Relate to Industry demands and structure project as per required specifications
3) Define Specifications for the execution of the project
4) Demonstrate game engine tools usage across art, animation, asset management, Interface, Audio, Lighting, Materials, Physics and Programming systems.
5) List and select gaming services related to project structure
6) Develop basic interactive games

Unit I: Introduction to Games Industry

Video game production techniques, hardware, production roles and responsibilities, Video game design elements, game genres, game types, examples of gaming platforms, gaming services, video game controls, video game industry terms, model asset optimization, asset store, video game art principles, video game industry practices, video game industry terminology

Unit II: Game Engine Fundamentals

Gaming engine user interface, hierarchy, editor, game Window, navigation, inspector, scene, project, game object, prefab, models, tags, sounds, assets, project management, materials, textures, effects, lights, modelling practices and optimization practices, Import system, managing materials, managing textures

Unit III: World Building and Animation

Environment, Static Meshes, Rigid Body, Colliders, Preparing for lighting, Light tools, light types, User Interface, Art principles, Sprite editor, Lighting process, Baking process, Animated objects, Importing animation, Setting up animation states, Animation controllers, Transition, Animation refinement.

Unit IV: Scripting a Game Development

Script types, Variables, Methods, C# fundamentals, Game mechanics, Ray casting, Program Debugging, Various Error states, Navigation, Nav Mesh, Building NPC, Simple AI, Enemy System, Particle system, Adding Game audio, Audio types, Audio formats, Audio clips and properties, Camera System, Building camera system, Player Behaviors, User Interface system, User Interface Implementation, Properties of UI, Build tools, Cloud Services, Console, Build Settings, Platforms, Publishing tools, Mobile Publishing

Term Work:

Develop a game "Roller Madness" in Unity environment as following assignments

1. Implement the Setting Up the Scene, Camera Setup
2. Implement the Physics system
3. Configure the Player Control and Appearance
4. Health and Damage, Pickups,
5. UI Basics and Game Manager,
6. Create the Enemies
7. Implement the Particle System
8. Implement Animations to the game avatar
9. Spawners to create multiple objects of same type

Note : Do any 6 assignments based on syllabus

Textbooks:

1. Tom Meigs, Ultimate Game Design: Building Game Worlds 1st Edition, McGraw-Hill Education, 2003
2. Sam R. Kennedy, How to Become a Video Game Artist: The Insider's Guide to Landing a Job in the Gaming World, Watson-Guptill, 2013

Reference Books:

1. Penny de Byl, Holistic Game Development with Unity: An All-in-One Guide to Implementing Game Mechanics, Art, Design and Programming, 2nd Edition, A K Peters/CRC Press, 2017
2. Mike Geig, Unity 2018 Game Development in 24 Hours, Sams Teach Yourself, 3rd Edition, Sams Publishing, 2018

OPEN ELECTIVE – I
Inferential Statistics for Data Science (IOEUA42172B)

Teaching Scheme	Examination Scheme						
Credits: 3 Lecture (L): 2 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisite: Basics of Probability

Course Objective(s):

- To equip students with the basic understanding of the fundamental concept of data and the nature of data sets
- To understand the fundamentals of probability distributions and their application for data analysis
- To derive the conclusions from the data sets with Bayesian and Inferential statistics

Course Outcomes:

Upon completion of the course, students will be able to

1. Comprehend and correlate the nature and central tendency of given data sets using appropriate probability distribution for the given data set.
2. Implement the fundamentals of Bayesian statistics to find out probability of unknown parameters of statistical model
3. Analyze and conclude the hypothesis using inferential statistical tests
4. Evaluate the prominent characteristics of data sets with exploratory data analysis methods

Unit I: Understanding Data and probability distributions

Understanding Data, Frequency Tables, Distributional Shapes, Central Tendency Describing Spread: Range, Interquartile Ranges and Standard Deviation , Measuring Data ,Measurements of Central Tendency, Measurements of Dispersion, Bi-variate Data and Covariance ,Pearson Correlation Coefficient, Uniform Distribution, Binomial Distribution, Poisson Distribution, Normal Distribution, Normal Distribution - Formulas and Z Scores

Unit II: Bayesian Statistics

Likelihood function and maximum likelihood, The minimaxity, Computing the MLE, Computing the MLE: examples ,Continuous version of Bayes' theorem, Priors and prior predictive distributions
Prior predictive: binomial example, Posterior predictive distribution, Bernoulli/binomial likelihood with uniform prior, Conjugate priors

Unit III: Inferential analysis

Central limit theorem and Hypothesis Testing, t-tests, Sensitivity Analysis ,chi square test, Correlation-values and confidence intervals, Use Analysis of Variance (ANOVA) or Analysis of Covariance (ANCOVA),Regression analysis

Unit IV: Exploratory Data Analysis

Univar ate data: measures of center and spread, transformations, visualization. – Bivariate data: Simple regression, curve fitting, – Trivariate/Hypervariate data: Multiple regression, model selection, principal components. – Binary responses: Logistic regression, residuals. – Categorical data: Contingency tables, correspondence analysis. – Distance data: Multi-dimensional scaling, non-linear dimensionality reduction. – Graph data: Descriptive statistics, spectral methods, visualization.

Term Work:

Practical's can be done using Python/R

1. Study of Hypothesis testing (One sample t test, z test)
2. Analysis of variance (ANOVA)
3. To study Linear regression to predict the outcome of a variable
4. Study of outlier in Predictive analysis
5. Finding the most important predictor variable in a dataset for feature Selection
6. Model selection and analysis for a real world dataset
7. Study of Logistic Regression
8. To build an application: Time series forecasting

Textbooks:

1. Sahu, Pradip Kumar, Pal, Santi Ranjan, Das, Ajit Kumar, "Estimation and Inferential Statistics", Springer
2. S.C. Gupta and V. K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 88, Daryaganj, New Delhi, 2.
3. Manoj Kumar Srivastava, Abdul Hamid Khan, Namrata Srivastava, "Statistical Inference, Theory of estimation", PHI

Reference Books:

1. George Casella, Roger Berger," Statistical Inference " CENGAGE Learning, Second Edition
2. Malcom O, Asadoorian, Demetri Kantarelis, "Essentials of Inferential Statistics", University Press of America

OPEN ELECTIVE – I
Solar and Wind Energy (IOEUA42172C)

Teaching Scheme	Examination Scheme						
Credits: 3 Lecture (L): 2 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisite: Basic Mechanical Engineering, Basic Electrical and Electronics Engineering

Course Objective(s):

- To understand fundamentals of solar and wind energies.
- To understand constructions, working principle and design procedure of solar and wind power plants.
- To apply basic engineering principle to design a simple solar and wind power system.

Course Outcomes:

Upon completion of the course, students will be able to

1. Understand solar radiation and geometry principles.
2. Apply aspects of solar thermal system and its practical applications.
3. To aware design process of solar food drier/solar cooker/solar pv system for domestic purpose.
4. Design miniature wind mill for domestic purpose referring existing system.

Unit I: Solar Energy Principles

Present solar energy scenario, world energy futures, governing bodies (self-study), solar radiations and its measurements, solar constant, solar radiation geometry, solar radiation data, estimation of average solar radiation, solar radiation on tilted surface.

Unit II: Solar Thermal Systems and Applications

Types of Solar thermal collector, flat plate collector analysis, Evacuated tube collectors (ETC) analysis, its design and application, solar air heaters and its types, solar distillation.
Solar Concentrating collectors: types- line and point concentrator, theory of Concentrating collectors, parabolic trough collector, parabolic dish collector, solar tower, concentrated Fresnel linear receiver (CFLR).

Unit III: Solar Photovoltaic and Applications

Forming the PN junction solar cells & its applications, Structure of a solar cell, types of modules, PV array, solar cell equation, Fill factor and maximum power, Grid aspects of solar power, equipment used in solar photovoltaic plants, Power Conditioning Equipment-inverters, Regulators, Other Devices; System Analysis-Design Procedure, Design Constraints, Other Considerations.

Unit IV: Wind Energy

Principle of wind energy conversion; Basic components of wind energy conversion systems; various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations, wind energy potential and installation in India.

Term Work:

1. Design of solar food drier for domestic purpose referring existing system.
2. Design of parabolic dish solar cooker for domestic purpose.
3. Design and analysis of liquid flat plate type heater used in domestic purpose

4. Design of solar photovoltaic system for domestic/ commercial building purpose.
5. Case study on designing miniature wind mill for domestic purpose referring existing system.
6. Visit to solar PV system used in commercial building.
7. Visit to wind power system used in commercial building.

Textbooks:

1. G. D. Rai, 'Non-Conventional Energy Sources', Khanna Publisher
2. S. P. Sukhatme, 'Solar Energy: Principles of thermal collections and storage', McGraw Hill
3. Tiwari G N. 'Solar Energy: Fundamentals, design, modeling and Applications', Narosa, 2002

Reference Books:

1. Mukund R. Patel, 'Wind And Solar Power Systems: Design, Analysis and Operation, Second Edition', CRC Press
2. Kreith And Kreider, Solar Energy Handbook, McGraw Hill
3. Ray Hunter, 'Wind Energy Conversion: From Theory to Practice', John Wiley and Son Ltd
4. Gary L Johnson, 'Wind Energy Systems', Prentice-Hall Inc., New Jersey
5. Martin O L Hansen, 'Aerodynamics of Wind Turbines', James & James/Earthscan.
6. Goswami D Y, Kreith F, Kreider J F, 'Principles of Solar Engineering', Taylor & Francis
7. Robert Gasch, 'Wind Power Plant Fundamentals, Design, Construction And Operations', Springer
8. C S Solanki, 'Solar Photovoltaic: Fundamentals, Technology And Applications', PHI Learning

OPEN ELECTIVE – I
Numerical Methods in Engineering (IOEUA42172D)

Teaching Scheme	Examination Scheme						
Credits: 3 Lecture (L): 2 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisite: Engineering Mathematics

Course Objective(s):

- To prepare the students to apply numerical methods to solve differential equations, integrations and simultaneous equations and perform regression analysis.

Course Outcomes:

Upon completion of the course, students will be able to

1. Apply curve fitting techniques, carry out regression and interpolation analysis of any engineering problem.
2. Solve simultaneous equations using numerical technique.
3. Perform numerical integration for any engineering problem.
4. Solve differential equation of any engineering problem using numerical technique.

Unit I: Curve Fitting, Regression and Interpolation

Curve fitting with Linear Equation, Criteria for a Best Fit, Linear Least Square Regression, Linear Regression Analysis, Coefficient of Determination, Polynomial Regression, Multiple Linear Regression,
Lagrange's Interpolation, Newton's Forward Interpolation, Hermit Interpolation, Inverse Interpolation

Unit II: Simultaneous Equations

Gauss Elimination Method, Partial Pivoting, Gauss Seidel Method, Gauss Jordan Method and Thomas Algorithms for Tridiagonal Matrix.

Unit III: Numerical Integration

Trapezoidal rule, Simpson's Rule ($1/3^{rd}$ and $3/8^{th}$), Gauss Quadrature2 point and 3 point method, Double Integration- Trapezoidal Rule, Simpson's $1/3^{rd}$ Rule

Unit IV: Numerical Solution of Differential Equations

Euler Method, Modified Euler Method (Iterative), Runga-Kutta Fourth Order Method, Simultaneous Equations using Runga-Kutta Second Order Method, Introduction to Finite Difference Method.

Term Work:

At least three assignments on each unit.

Textbooks:

1. Numerical methods- Rao V. Dukkipati- New Age International Publishers
2. Introductory Methods of Numerical Analysis- S.S.Sastry-University Press

Reference Books:

1. Numerical Methods in Engineering with Python 3 – Jaan Kiusalaas-Cambridge University Press
2. Numerical Methods -S. Balachandra Rao and C.K.Shantha, University Press

OPEN ELECTIVE – I
Social Media Analytics (IOEUA42172E)

Teaching Scheme	Examination Scheme						
Credits: 3 Lecture (L): 2 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisites:

1. Basic knowledge of Graphs.
2. Data mining.
3. Data Analysis

Course Objectives:

1. To understand foundations of Social Media Analytics.
2. To Visualize and understand the data mining aspects in social networks.
3. To solve mining problems by different algorithms.
4. To understand network measures for social data.
5. To understand behavioral part of web applications for Analysis.
6. To analyze the data available on any social media applications.

Course Outcomes:

Upon the completion of the course, students will be able to:

1. Understand the basics of Social Media Analytics.
2. Understand the visualization of social networks and the significance of Data mining in Social media.
3. Demonstrate the algorithms used for text mining.
4. Compare and Apply network measures for social media data.
5. Explain Behavior Analytics techniques used for social media data.
6. Apply social media analytics for Facebook, LinkedIn and Twitter kind of applications.

Unit I: Introduction to Social Media Analytics (SMA) and types of Analytics Tools

Social media landscape, Need for SMA; SMA in Small organizations; SMA in large organizations; Application of SMA in different areas

The foundation for analytics, Social media data sources, Defining social media data, data sources in social media channels, Estimated Data sources and Factual Data Sources, Public and Private data, data gathering in social media analytics

Unit II: The Social Networks Perspective and its Visualization

The social networks perspective - nodes, ties and influencers, Social network and web data and methods. Graphs and Matrices- Basic measures for individuals and networks.

A Taxonomy of Visualization, The convergence of Visualization, Interaction and Analytics. Data mining in Social Media: Introduction, Motivations for Data mining in Social Media, Data mining methods for Social Media

Unit III – Text Mining in Social Networks

Introduction, Keyword search, Classification Algorithms, Clustering Algorithms-Greedy Clustering, Hierarchical clustering, k-means clustering, Transfer Learning in heterogeneous Networks, Sampling of online social networks, Comparison of different algorithms used for mining, tools for text mining.

Unit IV: Network Measures
Centrality: Degree Centrality , Eigenvector Centrality, Katz Centrality , PageRank, Betweenness Centrality, Closeness Centrality ,Group Centrality ,Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence
Unit V: Behavior Analytics
Individual Behavior: Individual Behavior Analysis, Individual Behavior Modeling, Individual Behavior Prediction Collective Behavior: Collective Behavior Analysis, Collective Behavior Modeling, Collective Behavior Prediction
Unit VI - Case Study
Mining Twitter: Overview, Exploring Twitter's API, Analyzing 140 Characters Mining Facebook: Overview, Exploring Facebook's Social Graph API's, Analyzing Social Graph Connections Mining Linked In: Overview, Exploring Linked In API
Textbooks:
1. Reza Zafarani Mohammad Ali Abbasi Huan Liu, Social Media Mining, Cambridge University Press, ISBN: 10: 1107018854. 2. Charu C. Aggarwal, Social Network Data Analytics, Springer, ISBN: 978-1-4419-8461-6. 3. Matthew Ganis, Avinash Kohirkar Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media,Pearson publications,2016
Reference Books:
1. Marshall Sponder, Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics, McGraw Hill Education, 978-0-07-176829-0. 2. 2. Matthew A. Russell, Mining the Social Web, O'Reilly, 2nd Edition, ISBN:10: 1449367615. 3. Jiawei Han University of Illinois at Urbana-Champaign Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2nd Edition, ISBN: 13: 978-1-55860-901-3 ISBN: 10: 1-55860-901-6. 4. Bing Liu, Web Data Mining : Exploring Hyperlinks, Contents and Usage Data, Springer, 2nd Edition, ISBN: 978-3-642-19459-7

OPEN ELECTIVE – II
Fintech (Financial Technology) (IOEUA42173A)

Teaching Scheme	Examination Scheme						
Credits: 3 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): NA	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	-	100

Course Objective(s):

- To Introduce FinTech and its sub sectors
- To Explain the classification of various models of FinTech
- To Describe the innovation in FinTech
- To Introduce an innovative Fin Tech strategy
- To Study the development of FinTech Application and about future trends in Fin Tech

Course Outcomes:

Upon completion of the course, students will be able to:

1. Understand what FinTech is and the sub sectors that comprise it.
2. Classify various models of the Fintech
3. Illustrate various innovations done using latest technology trends in FinTech.
4. State the Critical Success Factors in Fin Tech.
5. Be able to adopt an innovative Fin Tech strategy within their own organization to lead a digital transformation project.
6. Develop the application using the concepts of FinTech as a case study

Unit I: Introduction to Fintech

Introduction, Financial Services and Fintech: Introduction, Changing Environment, Customer Centricity, Digital Transformation, Definition of Fintech, History of Fintech, Fintech stages, An Overview of Fintech Initiatives Around the World, Ecosystems, Ranking National Ecosystems, Downsides of Disruptive Fintech Initiatives.

Unit II: Model and Classifications

Introduction, Classification, Five Ws and one H : 1. Why a fintech initiative was born? 2. For whom was it born? 3. Which are the services it aims to provide? 4. Where does it aim to perform its business? 5. When does it aim to operate, within the framework of the financial cycle? 6. How is fintech working? The organization and its elements, The V4 business model framework, A Business Model, A Business Model for Fintech, Revenue—Focus on Customer Lifetime Value, Components of an effective marketing plan.

Unit III: Fintech Innovation

Introduction, Innovation and Fintech, Digital Transformation and Fintech, A model for an integrated innovation strategy, Types of Innovation : Product (or services), Process, Organization, Business models, Examples of Innovation, Fintech business model canvas, Process Innovation : Big Data Analytics, Value Creation from Big Data Analytics, Kreditech's self-learning algorithm, Internet of Things, Blockchain Technology, Organizational Innovation: Social Networks, Business Model Innovation, Robots, The V4 business model framework for Kreditech, Virtual Currencies, Technology Acceptance Model.

Unit IV: Critical Success Factors
The Model, Low-Profit Margin, Agility, Scalability, Security Management, Innovation, Ease of Compliance, Metrics, Fintech and Financial Services, Structure of fintech initiatives, The Challenges, Aspects to Consider, A Cooperation Model, Open Innovation
Unit V: Regulations
The Role of the Regulators, Equal Treatment and Competition, The Risks to Consider, Regtech, A Business Model for Insurtech Initiatives, Drivers of Disruption, The Impact of Technology, Insurance and Technology: Insurtech, Application of the Model to the Insurance Industry, The Empowerment of Customers, Mobility in Support of Insurance Companies, Digital Wholesale Insurance
Unit VI: A Case Study
Introduction, Robotica, Business Model Canvas, The Value Proposition, Customer Experience, Channels, Processes and Activities, Resources and Systems, Partnership and Collaborations, Revenues, Costs and Investments, The Future: Financial Services as Platforms
Textbooks:
1. Nicoletti, The Future of FinTech, 1st ed. Palgrave Macmillan, 2017 2. Kelvin Leong and Anna Sung "FinTech (Financial Technology): What is It and How to Use Technologies to Create Business Value in Fintech Way?" International Journal of Innovation, Management and Technology, Vol. 9, No. 2, April 2018
Reference Books:
1. Accenture. (2015). The future of Fintech and banking: Digitally disrupted or reimagined? Accenture Research, 1–12 2. Dietz, M., Khanna, S., Olanrewaju, T., & Rajgopal, K. (2015). Cutting through the fintech noise: Markers of success, imperatives for banks. Practice, G. B. (Ed.), 1–18. McKinsey and Company. Retrieved from http://www.mckinsey.com/ industries/financial-services/our-insights/cutting-through-the-noise round financial -technology. 3. "What is FinTech and why does it matter to all entrepreneurs?". Hot Topics. July 2014. retrieved December 9, 2014.

OPEN ELECTIVE – II
Agriculture Electronics (IOEUA42173B)

Teaching Scheme	**Examination Scheme**						
Credits: 3 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): NA	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	-	100

Prerequisite:

- Basic Electronics devices and their operations
- Basic understanding of sensors and transducers
- Basic Farming Activities

Course Objective(s):

Course Outcomes:

Upon completion of the course, students will be able to

- To empower the learner to recognize environmental problems and to provide solutions to agricultural sector.
- An over view of technology of advanced topics like DAS , SCADA and IOT .
- The ability to select the essential elements and practices needed to develop and implement the Engineering Automation for Agricultural sector.

Unit I: Introduction of Instrumentation system and Data acquisitions systems (DAS)

Introduction of Instrumentation system, Block diagram, Data loggers, Data acquisitions systems (DAS), Basics of PLC, Supervisory control and data acquisition (SCADA),

Unit II: Sensors and Transducers

Basic of sensors and transducers, Type of sensors, Performance terminology - Displacement, Velocity and Motion sensors - Proximity sensors, Force, Pressure,
Soil parameter measurement sensors - Flow, Level and Temperature sensors, Humidity, pH and Conductivity sensors, Specifications and selection criteria.

Unit III: Instrument technology for agriculture

Instruments for measurement of pH, Electrical conductivity, gas analysis, humidity, leaf area, chlorophyll content, and soil moisture & temperature.
Instrument for crop monitoring – moisture measurement – capacitive, infrared reflectance and resistance. Monitoring soil and weather – measurement of soil properties and meteorological parameters

Unit IV: Precision Farming

An introduction to precision farming. GIS/GPS positioning system for precision farming, Yield monitoring and mapping, soil sampling and analysis. Computers and Geographic information systems. Precision farming- Issues and conditions. Role of electronics in farm machinery for precision farming. Technology for precision farming.

Unit V: Control Applications in Farming

Irrigation control systems. Instruments for crop establishment monitoring. Crop spraying – selective crop spraying – flow control. Yield monitoring.
Instruments for protected cultivation – Green house environment control – transducers and control system. Instruments and systems for crop handling processing and storage.

Unit VI: SMART agriculture
Introduction to IOT, IOT in Agriculture, Wireless sensor networks , IOT network using LoRaWAN. Open Agriculture Initiative (OpenAg), **Agriculture & Electronics Governance:** Technological Difficulties in Indian Context, Governance products & services in agriculture sector, Role of Electronics Governance in Agricultural sector.
Textbooks:
1. K. Krishna Swamy, "Process Control"; New Age International Publishers. 2. C.S. Rangan, G.R. Sarma, V.S.V. Mani; " Instrumentation Devices and Systems "; Tata McGraw Hill; 2nd Edition 3. Curtis Johnson, "Process Control Instrumentation Technology"; 8th Edition, Pearson Education
Reference Books:
1. Shimon Y. Nof , "Springer Handbook of Automations", Springer. 2. Ernest O. Doebelin; " Measurement System Application and Design "; Mc-Graw Hill; 5th Edition 3. David G. Alciatore, Michael B Histand; " Introduction to Mechatronics and Measurement System "; Tata McGraw Hill 4. De Mess M. N. Fundamental of Geographic Information System. John Willy & sons, New York, Datta S.K.1987

OPEN ELECTIVE – II
Operation Research (IOEUA42173C)

Teaching Scheme	Examination Scheme						
Credits: 3 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): NA	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	-	100

Course Objectives:
To familiarize the students with various tools of optimization, probability and statistics as applicable scenarios in industry for better management of various resources

Course Outcomes:
Upon completion of the course, students will be able to:

1. Solve linear programming problems using appropriate techniques
2. Propose the best strategy using decision making methods under uncertainty and game theory
3. Apply the concept of transportation/assignment models to optimize available resources
4. Develop mathematical skill to solve inventory and replacement problems
5. Perform minimization of process time
6. Use CPM and PERT techniques, to plan, schedule, and control project activities.

Unit I: Introduction to Operations Research

Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research.
Linear Programming Problem: Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, Two-phase method, Duality

Unit II: Decision Theory and Theory of Games

Decision Theory: Meaning and Steps in Decision Making, Types of Management Decisions, Decision under Certainty, Decision under Risk, Decision under Uncertainty, Decision Trees
Theory of Games: Introduction, Minimax and Maximin Principle, Solution of Game with Saddle Point, Solution by Dominance, Solution by Graphical Method, m x n size Game Problem

Unit III: Transportation and Assignment Model

Transportation Model: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.
Assignment model: Formulation. Hungarian method for optimal solution. Solving unbalanced problem

Unit IV: Inventory Control and Replacement Analysis

Inventory Control: Basic Concepts, fixed order quantity inventory model, economic order quantity inventory models, probabilistic inventory model
Replacement Analysis: Replacement of Items that Deteriorate, Replacement of Items that Fail Suddenly: Individual replacement policy, Group replacement policy.

Unit V: Queuing Theory and Sequencing Model

Queuing Theory: Introduction, Basis Structure, Terminology (Kendal's Notations), Queuing Model M/M/1: /FIFO, M/M/c.
Sequencing models: Solution of sequencing Problem - Processing of n jobs through two machines, Processing of n jobs through three machines, Processing of two jobs through m Machines, Processing of n jobs through m Machines.

Unit VI: Project Management
Fundamentals of CPM and PERT networks, CPM: Construction of networks, Fulkerson's rule , Critical paths, Forward and backward pass, Activity Float analysis, Crashing Analysis, PERT: Time estimates, Construction of networks, Probability of completing projects by given date.
Textbooks:
1. Sharma S.D., "Operations Research", Kedarnath Ramnath and company publications. ISBN-13:1234567142552 2. Gupta P.K., Hira D.S., "Operations Research", S Chand and Co. Ltd., New Delhi. ISBN 13:9788121902816 3. Taha H.A., "Operations Research - An introduction", Prentice Hall Pvt. Ltd. ISBN-13: 978-0132555937
Reference Books:
1. Hillier F.S., Lieberman G.J., "Introduction to Operations Research", Tata McGraw-Hill. ISBN 978-0-07-337629-5 2. Wagner H.M., "Principles of Operations Research", Prentice-Hall India ISBN 978-0-9843378-2-8 3. Ravindran A., "Operations Research", Tata McGraw-Hill. New Delhi ISBN-13: 978-0471086086 4. Basu S.K., Pal D.K., and Bagchi H., "Operations Research for Engineers", Oxford and IBH Publishing ISBN 81-204-1251-6 5. Panneerselvam R., "Operations Research", Prentice Hall of India Ltd., New Delhi ISBN 81-203-1923-0

OPEN ELECTIVE – II
Total Quality Management (IOEUA42173D)

Teaching Scheme	Examination Scheme						
Credits: 3 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): NA	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	-	100

Course Objective(s):

1. Understand the basic principles of Quality and Total Quality Management.
2. Comprehend the customer satisfaction and customer involvement.
3. Acquire the knowledge of quality management tools and Statistical Process Control.
4. Acquire the knowledge of Management Information Systems
5. Understand fundamentals of Quality standards

Course Outcomes:

Upon completion of the course, students will be able to:

1. Understand Quality, Quality circle, basic concepts and barriers of Total quality Management. (**Understand**)
2. Explain TQM principles and concepts of Six sigma. (**Understand**)
3. Understand Total productive maintenance, FMEA and apply Benchmarking, QFD, House of quality, Pareto Analysis and Poka yoke. (**Understand, Apply**)
4. Understand and Apply Statistical Process Control SPC tools (**Understand, Apply**)
5. Understand fundamentals of Quality standards (ISO) (**Understand**)
6. Understand Management Information System for an organization. (**Understand**)

Unit I: Introduction to Quality and TQM

a. Definition of Quality, Importance of quality on a project in the context of global challenges, Dimensions of Quality, Quality Planning, Quality costs, Quality circle.
b. Basic concepts of Total Quality Management, Necessity and advantage, Historical Review, Contribution of Quality Gurus (Juran, Deming, Crossby, Ishikawa), Barriers of TQM – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints – Customer retention – Costs of Quality.

Unit II: TQM principles & Six Sigma

a. Principles of TQM, Continuous Process Improvement – Juran Trilogy, PDCA, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.
b. Six sigma – Importance, levels of six sigma, Defects & it's classification in construction. Measures to prevent and rectify defects.

Unit III: TQM Tools and Techniques

a. The seven tools of quality, Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Flow Charts – Pareto Analysis– Poka Yoke (Mistake Proofing)
b. Total Productive Maintenance (TPM) – Concept, Improvement Needs, Failure Mode Effect Analysis (FMEA)FMEA – Stages of FMEA

Unit IV: STATISTICAL PROCESS CONTROL (SPC)

a. Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Statistical Process Control: process flow diagram, cause and effect diagram, check sheets, histograms
b. Control charts: state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies

Unit V: Quality System (ISO)

a. Need of quality systems, Study of ISO 9001 principles, Quality manual – Importance, contents, documentation. Importance of check-lists in achieving quality.
b. Corrective and Preventive actions, Quality Audits, Conformity and NC reports, TS16949, ISO 14000 – Concept, Requirements and Benefits

Unit VI: Management Information System

a. Introduction to Management Information systems (MIS) Overview, Definition. MIS and decision support systems, Information resources, Management subsystems of MIS
b. MIS based on management activity whether for operational control, management control, strategic control. Study of an MIS for an organization

Textbooks:

1. Total Quality Management-- Dr. Gunmala Suri and Dr. Puja Chhabra Sharma—Biztantra.
2. Quality Control and Total Quality Management by P.L.Jain- Tata McGraw Hill Publ. Company.
3. Total Quality Management - Dr. S.Rajaram and Dr. M. Sivakumar—Biztantra.
4. Total Engineering Quality Management – Sunil Sharma – Macmillan India Ltd.

Reference Books:

1. Juran's Quality Handbook – Juran Publication. Importance of quality on a project in the context of global challenges. Importance of quality on a project in the context of global challenges.
2. Management –Principal, process and practices by Bhat – Oxford University Press.
3. Financial management by Shrivastava- Oxford University Press.
4. Management Information Systems – Gordon B. Davis, Margrethe H. Olson – Tata McGraw Hill Publ. Co.
5. Total Project Management – The Indian Context - P.K.Joy Macmillan India Ltd.

E- Sources:

www.nptel.ac.in , www.mobile.enterpriseappstoday.com

OPEN ELECTIVE – II
Blockchain Technology (IOEUA42173E)

Teaching Scheme	**Examination Scheme**						
Credits: 3 Lecture (L): 3 hrs./week Tutorial (T): NA Practical (P): NA	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	-	100

Course Objective(s):

- To understand the basic fundamentals of Blockchain
- To introduce Bitcoin Blockchain
- To explain blockchain creation process
- To know the importance of Hyperledger
- To gain knowledge about the multichaining
- To discuss the emerging trends in Blockchain and Use cases

Course Outcomes:

Upon completion of the course, students will be able to:

1. Get fundamental knowledge of Blockchain
2. Know about Bitcoin Blockchain
3. Understand blockchain creation process
4. Explore Hyperledger
5. Know Emerging Trends in Blockchain

Unit I: Overview of Blockchain

Basics of Blockchain, History of Blockchain, Network and protocols, Smart Contract and Consensus Algorithms, Blockchain users and adoption, Blockchain challenges

Unit II: Bitcoin Blockchain

Blockchain TOC Bitcoin/ Blockchain data structures, Keys as identity, Digital Signatures, Hashes, Hashes as Addresses, Hash Pointers and Data Structures, Blockchain transactions, Blockchain block structure

Unit III: Creating the Blockchain: Mining

Mining explained, The bitcoin network, The bitcoin Minning Process, Minning Developments

Unit IV: Hyperledger

Overview of Hyperledger, Hyperledger Projects, Hyperledger Architecture, Consensus model for permissioned Blockchains, Consensus and its interaction with architectural layers, Architecture of Enterprise level Blockchain applications.

Unit V: Blockchain on Multichain

Introduction to Multichain, Privacy and Permissions in Multichain, Features of Assets in Multichain, Multichain Streams, Mining in Multichain, Interactive mode commands, Round Robin Mining

Unit VI: Emerging Trends in Blockchain and Use cases

Transaction limitations, Additional blockchains, Hyperledger, Ethereum, Ripple, R3, Blockchain and cloud computing, Cloud -Based Blockchains,
Blockchain Use cases, Blockchain and Artificial Intelligence.

Textbooks:
1. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos 2. Blockchain by Melanie Swa, O'Reilly 3. Hyperledger Fabric - https://www.hyperledger.org/projects/fabric
Reference Books:
1. Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits - https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html

Introduction to Research (CVUA42174)

Teaching Scheme	Examination Scheme						
Credits: 2 Lecture (L): 1 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	-	-	-	-	-	25	25

Course Objective(s):

- To study fundamental concepts of Research
- To study Technical Writing

Course Outcomes:

Upon completion of the course, students will be able to:

1. Explain the basics of research methodology
2. Write and publish research article

Unit I: Introduction to Research

Overview of Research, Meaning of Research, Objectives, Types, Research Approaches, Significance, Research Methods vs Methodology, Research and Scientific Methods, Research Process. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Techniques involved in defining a problem, Data Collection, Preparation and analysis

Unit II: Technical Writing and Research Ethics

Technical Presentation and Technical Writing, Why Technical Writing, Layout of Technical Report/Article, Abstract, Introduction, Literature Survey-Overview of Literature Survey-Searching literature, Sources of Literature, Literature Survey and Reviewing Literature, Organizing Literature, Some Terminology-ISBN, ISSN, DOI, Bib TeX, Strategies to Search- Keyword search, Backward and Forward Chronological Search, Adding References to document, New Findings, Experimental Details, Results and Discussion. Plagiarism tools, Publication process of Technical articles

Term Work:

1. Assignment based on Data Collection and Data Preparation Process
2. Assignment based on statistical tools
3. Adding References in research paper using BibTex Referencing in Latex or Using Bibliography citations in Microsoft word
4. Project: Write and Publish a Research Article

Textbooks:

- Kothari C.R., Research Methodology (2nd Ed.), New Age International, (2004); ISBN(13): 978-81-224-1522-3 2.

https://drive.google.com/file/d/1DVenZVYnCjLx1p0T5ZF- XC8pY_8FRADL/view

Reference Books:

1. Berkman, Elliot T., A Conceptual Guide to Statistics Using SPSS, Sage Publications, 2011; ISBN: 978-1-4129-7406-6
2. Kumar, Ranjit, Research Methodology (3rd Ed); Sage Publications, 2011; IBSN: 978-1-8492-0301-2 3.