

Q-Examination Syllabus

Common Subject for all Specialization of SIF

Subject Name: Applied Statistics

Syllabus: Measures of central tendency: mean, median and mode, Measures of dispersion: standard deviations and variance, normal distribution, Poisson and binomial distributions, Goodness-of-fit test for discrete and continuous data set, Test of hypothesis: test of significance for large and small samples, single-tailed and two-tailed t-test, Regression analysis: simple linear regression, multiple linear regression, least squares estimation, scatter diagram.

Reference Books:

- Fundamentals of Statistics- S. C. Gupta
- Fundamentals of Mathematical Statistics - S. C. Gupta and V. K. Kapoor
- SCHAUM's Outlines Statistics- Theory and Problems of Statistics.
- Comprehensive Statistical methods- P. N. Arora, Sumeet Arora, and S. Arora

(Specialization wise subjects)

1. Environmental Engineering

Subject Name: Water Treatment Engineering
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Syllabus:

Water requirements, types of water demands, water demand forecasting, surface water and groundwater sources, water quality parameters (physical, chemical and biological) and drinking water standards, water treatment systems, Physico-chemical processes, aeration, sedimentation, coagulation, flocculation, granular media filtration, chlorination, water softening by chemical and ion exchange methods, determination of reservoir capacity, gravitational, pumping and combined water supply schemes, distribution reservoirs and service storage, distribution networks (dead-end, closed systems by Hardy-cross method and equivalent pipe method).
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Reference Books:

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| <ul style="list-style-type: none">• Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw-Hill International Ed.• Bhave P. R. and Gupta R., Analysis of Water Distribution Networks, Narosa publishing house, New Delhi.• Qasim S. R., Motley E. M. and Zhu G., Water Works Engineering- Planning, Design and Operation, Prentice Hall.• Hammer M. J., Water and Waste water Technology, PHI Learning.• McGhee T. J., Water Supply and Sewerage, McGraw Hill International. |
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Subject Name: Solid Waste Management

Syllabus:

Municipal Solid Waste: Sources, Composition and Characteristics, Integrated Solid Waste management system: Generation, Storage Segregation, Collection, Reuse and Recycling possibilities, Transfer and Transport (Haul Container and Stationary Container System). Treatment/Processing and Transformation Techniques: Biological Transformation (Composting, Anaerobic Digestion), Thermal Conversion technologies (Incineration, pyrolysis and gasification). Final disposal of solid waste including sanitary landfill, planning, siting, design, closure, and post-closure monitoring.

Reference Books:

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| <ul style="list-style-type: none">• Tchobanoglous G., Theisen H., and Vigil S.A., Integrated Solid Waste Management: Principles and Management Issues, McGraw Hill Book Company, 1993.• Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw-Hill International Edition. |
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- Vesilind P.A., Worrell W and Reinhart, Solid waste Engineering, Thomson Learning Inc., Singapore, 2002.
- Bhatia, S. Solid and Hazardous Waste Management, Atlantic Publishers & Distributors
- Sincero A.P. and Sincero G.A., Environmental Engineering A Design Approach, Pearson Publication

Subject Name: Wastewater Treatment

Syllabus:

Components of wastewater flows, sanitary collection, storm collection and combined collection systems, Wastewater characteristics, Types of reaction, Reaction rates and order, Type of reactors, Biomass growth curve, Suspended growth process, Mass balance analysis for biomass and substrate in activated sludge process (ASP), modifications in conventional ASP (complete mix, plug flow, tapered aeration, step aeration, oxidation ditch, contact stabilization, sequencing batch reactor, extended aeration, pure oxygen system), Attached growth process, Trickling filter, Bio-tower, rotating biological contactor, Anaerobic treatment, Up flow sludge blanket reactor, Constructed wetland, Sludge management (Sludge dewatering, Aerobic and anaerobic sludge digestion, disposal)

Reference Books:

- Metcalf & Eddy., Wastewater Engineering- Treatment and Reuse (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill.
- Central Public Health and Environmental Engineering Organization, Manual on Water Supply and Treatment, 2nd Ed, Ministry of Urban Development, New Delhi December.
- Hammer M. J., Water and Waste water Technology, PHI Learning.
- McGhee T. J., Water Supply and Sewerage, McGraw Hill International.
- Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw-Hill International Ed.
- Quasim S. R., Motley E. M. and Zhu G., Water Works Engineering- Planning, Design and Operation, Prentice Hall.
- Eckenfelder, W. W., Jr. (2000) Industrial Water Pollution Control, 3d ed., McGraw-Hill

Geotechnical Engineering

Subject Name: Mechanics of Soils

Syllabus:

Index properties, clay mineralogy, structural arrangement of grains, classification of soil using BIS codes. Effective stress concepts in soils. Permeability, Darcy's law, determination of permeability, laboratory determination (constant head and falling head methods), and field measurement pumping out in unconfined and confined aquifers. Factors influencing permeability of soils, seepage, two-dimensional flow, Laplace's equation, introduction to flow nets. Compaction theory, laboratory and field Compaction, factors influencing compaction. Consolidation settlement, Terzaghi's one-dimensional consolidation theory, e -log p relationship, estimation of primary consolidation settlement for NC and OC clays. Shear strength of soils, Mohr-Coulomb failure theory, measurement of drained and undrained shear strength parameters using direct shear & triaxial compression (UU, CU, and CD tests), UCC, and Vane shear tests, pore pressure parameters, factors that influence shear strength of the soil.

Reference Books:

- Bowles, J. E. (1996). Foundation Analysis and Design, McGraw-Hill, Singapore.
- Budhu, M. (2000) Soil Mechanics and Foundations, John Wiley & Sons Inc., New York, N.Y.
- Cernica, John N (1995) Geotechnical Engineering: Foundation Design, John Wiley & Sons, New York, N.Y.
- Clayton, C. R. I., Woods, R. I., Bond, A. J. and Milititsky, J. (2013). Earth Pressure and Earth-Retaining Structures, CRC Press, Boca Raton, Florida.
- Coduto, D. P. (2001). Foundation Design Principles and Practices, Prentice Hall, Upper Saddle River, New Jersey.
- Das, B. M. (2011). Principles of Foundation Engineering, PWS Publishing, Pacific Grove, California.
- Day, Robert W. (2005) Foundation Engineering Handbook, McGraw Hill, New York, N.Y.
- Fang, H. Y. (2004). Foundation Engineering Handbook, CBS Publishers and Distributors, New Delhi.
- FHWA (2009) Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, Volumes I&II, US Department of Transport, Federal Highway Administration, Washington, DC, USA Publication No. FHWA-NHI-10-025
- Peck, R. B., Hanson, W. E. and Thornburn, T. H. (1974). Foundation Engineering, John Wiley and Sons, New York.
- Ranjan, G. and Rao, A. S. R. (2000). Basic and Applied Soil Mechanics, New Age International (P) Ltd., New Delhi.
- Shukla, S.K. (2012) Handbook of Geosynthetic Engineering, ICE Publishing, London, UK.
- Terzaghi, K., Peck, R. B. and Mesri, G. (1996). Soil Mechanics in Engineering Practice, John Wiley and Sons, New York.

Subject Name: Ground Improvement**Syllabus:**

Introduction; the necessity of ground improvement; methods of ground improvement for cohesive soils and cohesionless soils; Selection of suitable ground improvement techniques. Preloading, accelerated consolidation using sand drains and prefabricated vertical drains, stone columns, vibro-compaction, dynamic compaction, blast densification, grouting, soil stabilization: lime, fly ash, cement, asphalt; micropiles, deep soil mixing; Introduction to Geosynthetics; Basic description of geosynthetics; Types and functions of geosynthetics; Engineering properties of geosynthetics and their evaluation; Testing of geosynthetic materials; Design methodologies for mechanically stabilized earth retaining walls.

Reference Books:

- Buddhima Indraratna and Jian J Chu, Ground Improvement: Case Histories, Elsevier.
- Chris A. Raison, Ground and Soil Improvement, Thomas telford, UK.
- Das, B. M. Principles of Foundation Engineering, Cengage Learning.
- Moseley M.P. and Kirsch, K. Ground Improvement, Spon Press, Taylor and Francis Group.
- Puroshothama Raju, P. Ground Improvement Techniques, Laxmi Publications, New Delhi.

Subject Name: Foundation Analysis and Design**Syllabus:**

Shallow foundation: Bearing capacity factors. Effect of foundation shape, eccentricity and inclination of load, Influence of soil compressibility, and water table. Settlement of shallow footings: spread, mat, or raft foundations. Deep foundations: Modes of failure. Bearing capacity and settlement of pile foundation. Types of piles. Pile and pile Groups under axial loading; Allowable load, Pile Load Test. Dynamic and static formulae. Bearing Capacity factors. Pile group bearing capacity and settlement. Analysis of elastic stress and settlement; Retaining Structures: Earth Pressure theories, gravity and rigid cantilever walls, sheet pile wall.

Reference Books:

- Budhu, M., Soil mechanics and foundations, Wiley Publishers, New Delhi.
- Coduto, D.P., Foundation design: Principles and Practices, Prentice Hill Publishers.
- Das, B. M. Principles of Foundation Engineering, Cengage Learning.
- Das, B.M. Shallow Foundations: Bearing Capacity and Settlement, CRC Press.
- Holts R.D. and Kovacs, W.D. An introduction Geotechnical Engineering, Prentice Hall.
- Poulos, H.G. and Davis E.H. Pile Foundation Analysis and Design.
- Salgado, R. The engineering of foundations. Tata Mc.Graw Hill Edu. Pvt. Ltd. New Delhi. 2011
- Tomilson, M.J. Foundation Design and Construction, Pearson Publishers.

Subject Name: Soil Dynamics

Syllabus:

Vibration of elementary systems: Single Degree and Multiple Degrees of Freedom; Transient vibrations; Liquefaction of soils: Cyclic mobility and flow liquefaction, evaluation of liquefaction potential using cyclic stress approach, Laboratory and field evaluation of dynamic soil properties as per IS Codes; Vibration isolation and damping; Propagation of elastic waves in soils - P-wave, S-wave, R wave and L-wave; waves in layered soils.

Reference Books:

- Braja Das, G.V. Ramana, Principles of Soil Dynamics, Cengage Learning, USA.
- Milutin Srbulov, Practical Soil Dynamics: Case Studies in Earthquake and Geotechnical Engineering, Springer link Publishers.
- Prasad Bharat Bhushan, Fundamentals of Soil Dynamics and Earthquake Engineering, PHI Publisher, New Delhi.

2. Structural Engineering

Subject Name: Structural Dynamics and Earthquake Engineering

Syllabus: Single-degree-freedom systems: undamped and damped free vibration; Response to harmonic and periodic excitations; Generalized single-degree-freedom systems. Multi-degree-freedom systems: Equation of motion; undamped free vibration; Modal analysis; Characteristics of earthquakes; Response spectrum, Earthquake response of structures; Code provisions for earthquake resistant design of buildings: Equivalent Static Method and Responses Spectrum Method.

Reference Books:

- Chopra, A.K., Dynamics of Structures: Theory and Applications to Earthquake Engineering, Prentice Hall/Pearson Education
- Clough, R.W. and Penzien, J., Dynamics of structures, McGraw Hill, Inc., New York
- Craig, R.R., Structural Dynamics: An Introduction to Computer Methods, Wiley New York
- Meriovitch, L., Elements of vibration analysis, McGraw-Hill
- Rao, S.S., Mechanical Vibrations, Pearson
- Thomson, W.T., Theory of Vibration with Application, CRC Press
- Murty C.V.R., Earthquake tips, Learning Earthquake Design and Construction, IITK BMTPC.
- Duggal, S.K., Earthquake Resistant Design of Structures, Oxford University Press
- Bolt, B.A., Earthquakes, W.H. Freeman

Subject Name: Analysis of Structures

Syllabus: Analysis of Statically Determinate Structures; Review of shear force and bending moment diagrams in beams and frames; Plane trusses: Deflection of trusses; Deflection of beams and frames; Influence line diagrams and moving loads; Analysis of Statically Indeterminate Structures; Force and stiffness methods of analysis; Introduction to Matrix method of analysis of trusses, beams and 2D frames.

Reference Books:

- Hibbeler, R.C., *Structural Analysis*, Pearson
- Kassimali, A., *Structural Analysis*, Fourth Edition, Cengage Learning
- Menon, D. *Structural Analysis*, Narosa Publishing House.
- Wang, C.K. *Intermediate Structural Analysis*, McGraw Hill Education (India) Pvt Ltd.
- Vazirani V.N. and Ratwani M.M. *Analysis of Structures Vol-1, Vol-2*, Khanna Publishers.
- Bhavikatti, S.S. *Structural Analysis, Vol-I and II*, 4th Edition, Vikas Publishing House Pvt Ltd.

Subject Name: Design of Reinforced Concrete and Steel Structures

Syllabus: Basics of Limit State Design of RCC Members; Assumptions in the LSM of design; Design of RC Beams for Bending Moment, Shear Force, Bond and Torsion. Axially and eccentrically loaded RC Columns. Design of RCC one-way and two-way slabs. Introduction to Steel Structure Design: Structural Systems, Design Loads and Load Combinations, Rolled and Built-up sections; Limit State Design Methods; Design of structural fasteners: bolts and welds; Simple and eccentric Connections; Design of tension members; Design of compression members; Design of flexure members.

Reference Books:

- Gambhir, M.L., *Design of Reinforced Concrete Structures*, PHI Learning
- Varghese, P.C., *Limit State Design of Reinforced Concrete*, PHI Learning
- Pillai, S.U. and Menon, D., *Reinforced Concrete Design*, Tata McGraw Hill
- Punmia, B.C., Jain A.K. and Jain A.K., *Reinforced Concrete Structures Vol-I and II*, Laxmi Publications
- Subramanian, N., *Design of Steel Structures*, Oxford University Press
- Duggal, S.K., *Limit State Design of Steel Structures*, McGraw Hill
- Ram, K S, *Design of Steel Structures*, Pearson Education

Subject Name: Mechanics of Solids

Syllabus: Stress- Theory of stress, Differential equation of equilibrium, Stress tensor, Transformation of plane stresses and Mohr's circle, Stress analysis of axially loaded bar, State of deformation and strain, Generalized Hooke's law- Stress-strain (constitutive) relationship, Plane stress and plain strain problems, Thin-walled pressure vessels, Torsion-solid circular shaft, thin walled tube, Bending of symmetric beam- Shear force and bending moment, Bending stresses, Shear stresses in bending, Shear flow, Analysis of short column and long column.

Reference Books:

- Gere, J.M. and Goodno, B.J., "Mechanics of Materials," Cengage Learning
- Timoshenko, S.P. and Young, D.H., "Elements of Strength Of Materials", Affiliated East West Press Pvt. Ltd
- Crandall, S.H., Dahl, N.C. Lardner, T.J., and Sivakumar, M.S., "An Introduction to the Mechanics of Solids," Tata McGraw Hill
- Popov, E.P., "Engineering Mechanics of Solids," Prentice Hall India
- Shames, I.H. Pitarresi, J.M., "Introduction to Solid Mechanics," Prentice-hall of India

Subject Name: Concrete Technology

Syllabus: Fundamental of concrete - constituents, proportioning, mixing, transportation, placing and curing, Properties of fresh and hardened concrete., Quality control in concrete construction, Concrete mix design, Durability of concrete - alkali aggregate reaction, reinforcement corrosion, freezing and thawing, etc., Special concretes - high strength, low heat of hydration, high early strength, self-compacting, lightweight etc., Construction methods – shortcrete, roller compacted concrete, etc., Reinforcing materials – epoxy coated bars, fibre-reinforced plastics, Introduction to 'maintenance' of concrete structures - use of non-destructive testing, evaluation criteria.

Reference Books:

- Gambhir, M.L., Concrete Technology, Tata Mcgraw Hill
- Neville, A.M. and Brooks, J.J., Concrete Technology, Neville, ELBS/Longman
- Neville, A.M., Properties of Concrete, ELBS/Longman
- Ghose, D.N., Construction Materials, Tata Mcgraw Hill
- Mehta, P.K. and Montiero, P.M.J., Concrete Material, Microstructure and Properties, Tata Mcgraw Hill

3. Transportation Engineering

Subject Name: Traffic Engineering**Syllabus:**

Traffic characteristics : Driver behaviour and vehicular characteristics, uniform and non-uniform acceleration theory, traffic studies- volume, speed and delay studies, elements of traffic flow theory, peak hour volume and peak hour factor, highway capacity, PCU concept, Greenshields' and Greenberg models, mathematical theories of traffic flow (Poisson arrivals, binomial and negative binomial distributions), gap acceptance, critical gap estimation, moving observer method, study of delay at controlled and uncontrolled junctions, queuing theory, capacity and LOS of uninterrupted facilities, traffic characteristics at un-signalised intersections.

Reference Books:

- Kadiyali, L.R. Traffic Engineering and Transport Planning, Khanna Publisher
- Chakroborty, P. and Das, A. Principles of Transportation Engineering, PHI pub.
- Khisty & Lal, Transportation Engineering, Prentice Hall India.
- Khanna S. K., Justo, C.E.G and Veeraraghavan, A., Highway Engineering, Nem Chand & Bros. Pub.
- Garber, N.J. and Hoel, L.A., Traffic and Highway Engineering. 5th Edition, Cengage Learning Pub.

Subject Name: Transportation Planning**Syllabus:**

Fundamental of transportation system planning, basics of Four-Steps travel demand forecasting, trip generation, trip production and trip attraction model, trip purpose, regression model and category analysis; trip distribution model: Growth factor method, uniform method, average growth factor method, Frater method, Synthetic method: Gravity method, singly constrained and doubly constrained approaches; modal split: trip interchange modal split model, Logit model; trip assignment model: user-equilibrium model, system optimal model.

Reference Books:

- Kadiyali, L.R. Traffic Engineering and Transport Planning, Khanna Publisher
- Chakroborty, P and Das, A. Principles of Transportation Engineering, PHI pub.
- Sarkar, P.K. and Maitri, V. and Joshi, B.G.J. Transportation Planning- Principles, Practices and Policies, PHI pub.

Subject Name: Highway Geometric Design**Syllabus:**

Elements of geometric design of highways, stopping sight distance, overtaking sight distance, types of overtaking in Indian context, horizontal alignment, transition curves, super elevation and side friction, vertical alignment: - grades, crest and sag curves. At grade Inter-sections- sight distance consideration and principles of design, channelization, mini roundabouts, layout and design of roundabouts, extra widening of pavements on horizontal curves and at median openings, acceleration and deceleration lanes.

Reference Books:

- Kadiyali, L.R. Traffic Engineering and Transport Planning, Khanna Publisher
- Chakroborty, P and Das, A. Principles of Transportation Engineering, PHI pub.
- Khanna S. K., Justo, C.E.G and Veeraraghavan, A., Highway Engineering, Nem Chand & Bros. Pub.
- Garber, N.J. and Hoel, L.A., Traffic and Highway Engineering. 5th Edition, Cengage Learning Pub.

Subject Name: Pavement Materials**Syllabus:**

Characterization of soil and unbound granular materials, Soil Stabilisation, Properties of bitumen, emulsion, and modified binders, Rheology of bitumen, bituminous mix design (Marshall and SuperPave methods), Volumetric Properties, Rutting and Fatigue performance tests on bituminous mixes.

Reference Books:

- A. T. Papagiannakis and E. A. Masad, Pavement Design and Materials, Wiley Publications
- Khanna S. K., Justo, C.E.G and Veeraraghavan, A., Highway Engineering, Nem Chand & Bros. Pub.
- Athanassios Nikolaidis, Highway Engineering: Pavements, Materials and Control of Quality, CRC Press.
- P. S. Kandhal, Bituminous Road Construction in India, PHI Pub.
- Chakroborty, P. and Das, A. Principles of Transportation Engineering, PHI pub.

Subject Name: Pavement Design**Syllabus:**

Type of Pavements, philosophy of pavement design, Pavement Composition, factors affecting pavement design (traffic & loading, pavement component materials, Climatic conditions, failure criteria, reliability etc.), Stresses in flexible pavement, Stresses in rigid pavement, Design of flexible, composite and rigid pavements.

Reference Books:

- Y. H. Huang, Pavement Analysis and Design, Pearson Education.
- E.J. Yoder and M. W. Witzak, Principles of Pavement Design, McGraw Pub.
- Chakroborty, P. and Das, A. Principles of Transportation Engineering, PHI pub.
- Athanassios Nikolaidis, Highway Engineering: Pavements, Materials and Control of Quality, CRC Press.

4. Water Resources Engineering**Subject Name: Groundwater Hydrology**

Syllabus: Groundwater in hydrologic cycle; Occurrence and movement; Aquifers and their characteristics/classification, Darcy's law, Dupuit's assumptions; Flow nets; Groundwater tracers; Well hydraulics: steady/unsteady, uniform/radial flow to a well in a confined/unconfined/leaky aquifer; Global climate change and groundwater; Artificial recharge.

Reference Books:

- Todd, D. K. and Mays, L. W., Groundwater Hydrology, Third Edition, John Wiley & Sons, Inc., 2005.
- Mays, L. W., Ground and Surface Water Hydrology, John Wiley & Sons, Inc., 2011.
- Mackay, R. & Riley, M., Groundwater Modeling, in *An Introduction to Water Quality Modelling* Second Edition, Ed: A. James, Wiley Publishers, 1992.
- Hiscock, K. M. and Bense, V. F., Hydrogeology: Principles and Practice, Second Edition, Wiley-Blackwell, 2014.

Subject Name: Surface Hydrology

Syllabus: Hydrologic cycle, water budget equation, precipitation: measurement, preparation and measurement, depth-area-duration relationships, intensity-duration-frequency relationships, Abstractions: measurements and estimations, Streamflow measurement: direct and indirect methods, permanent and shifting control, flow duration and flow mass curve, sequent peak algorithm, hydrographs, unit hydrograph (UH), S curve, synthetic UH, distribution graph, Instantaneous UH, Flood frequency studies, Flood routing, hydrologic routing, hydraulic routing.

Reference Books:

- Ven Te Chow (Editor), Handbook of Applied Hydrology: A Compendium of Water-resources Technology, McGraw-Hill, New York, 1964.
- VenTe Chow, Maidment, D. and Mays, L.W., Applied Hydrology, Second Edition, McGraw-Hill Inc., New York, 2013.
- Yevjevich, V., Probability and Statistics in Hydrology, Water Resources Publications, Fort Collins, Colorado, 1972.
- Singh, V. P., Elementary Hydrology, Prentice Hall, 1992.
- Maidment, D. R., Handbook of Hydrology, McGraw-Hill Inc., 1993.

Subject Name: Open Channel Hydraulics

Syllabus: Classification of flows, types of channels, velocity distributions, correction factors, pressure distribution, equation of continuity for steady and unsteady flows, energy equation, momentum equation, specific energy, critical depth, channel transitions, uniform flow, Chezy equation, Manning formula, open channel velocity distribution, equivalent roughness, normal depth, hydraulically efficient channel sections, compound channels, divided channel method, gradually varied flow (GVF), differential equation of GVF, flow profiles, rapidly varied flow (RVF), momentum equation, hydraulic jump over various cross sections and slopes, unsteady flows, equation of continuity, St. Venant equation, uniformly progressive wave, surges.

Reference Books:

- Subramanya, K., Flow in Open Channels, Third Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.

- Chanson, H., The Hydraulics of Open Channel Flow: An Introduction, Second Edition, Elsevier, 2004.
- Ven Te Chow, Open Channel Hydraulics, Reprint, Blackburn Press, 2009.
- French, R. H., Open Channel Hydraulics, Water Resources Publications, LLC, 2007.
- Sturm, T. W., Open Channel Hydraulics, Second Edition, McGraw-Hill, New York, 2010.