

Syllabus for Operational Research (SCPH22)

Note:

- i. There will be one Question Paper which will have 100 questions.
- ii. All questions will be compulsory.
- iii. The Question Paper will have two Parts i.e. Part A and Part B
- iv. Part A will have 50 questions based on Research Methodology
- v. Part B will have 50 questions based on Subject-Specific Knowledge.

Unit 1 Inventory and Production Management

- ❖ Deterministic Inventory Lot-Size Models with Time proportional demand, Deterministic Joint replenishment policy, Inventory Control of deteriorating Items (discrete and continuous), Inventory Control under Inflationary Conditions, Inventory models with stock dependent demand, Interaction of Inventory and trade credit policies, Impact of marketing policies on Inventory decisions, Joint buyer-seller inventory model.
- ❖ The Distribution free newsboy problem and its extensions.
- ❖ Aggregate Production Planning: Fixed and Variable Work Force Model, Inventory Location Model, Production Planning with Time Varying Demand.

Unit 2: Marketing Management

- ❖ Consumer Behavior, Market Segmentation, Purchasing under varying Marketing Parameters viz. Price, Quality, Promotional Efforts and Distribution Expenditure, Promotional and Pricing decisions under Competition, Media Planning and Media Allocation Models, Promotional Effort Allocation Models, The carry over effect of Advertising, Models determining the optimal return on Investment for an advertising Campaign
- ❖ Diffusion of Products and Services, Diffusion of Multi-Generational Technological Innovations, Optimal timing of introduction of new Generations, Diffusion of Products

with Limited Supply and Known Expiration Date

Unit 3: Mathematical Programming

- ❖ Generalized Convexity: Invexity and its Generalization, Optimality and Duality under invexity.
- ❖ Complementarity Problem: Linear Complementarity Problem (LCP), Applications of LCP, Complementary Pivot Algorithm and Its variants, Vertical LCP, Horizontal LCP, Generalized Leontief input-output model as vertical LCP.
- ❖ Bi-Level Programming: Linear Bilevel Programming, Existence of Optimal Solutions, Optimality Conditions, Solution Algorithms.
- ❖ Vector Optimization: Pareto Optimality, Optimality Conditions, Solution Algorithms, Interactive Approaches, Goal Programming

Unit 4: Theory of Reliability

- ❖ Product Life Cycle, Reliability Planning and Specification. System Reliability and Optimization: System Structure Analysis: Coherent Structures, Structures represented by Paths and Cuts, Pivotal Decomposition, Modules of Coherent Structures, Exact System Reliability, Multistate Coherent Systems. Principles of Importance Measures: Reliability importance measures, Lifetime importance measures, Structure importance measures, State – Space Method for System Reliability Evaluation, Dependent Failures: Modeling of Dependent Failures, Associated Variables, Combinatorial Reliability Optimization: Combinatorial Reliability Optimization Problems of Series Structure and Non-Series Structure, Combinatorial Reliability Optimization with Multiple choice Constraints, Optimal Redundancy Problems.
- ❖ Reliability Testing: Life Testing Models, Burn-in tests, Bogey Testing.
- ❖ Maintenance Models: Random Point Processes in System Replacement, Time-Based System Replacement, and System Replacement Based on Cost Limits, Maintenance Models with General Degree of Repair, Inspection of Systems.

Unit 5: Software Reliability

- ❖ Introduction to Software Reliability, Software Development Life Cycle, Software Testing (Verification & Validation), Error, failure and faults in Software, Difference between Hardware & Software Reliability

- ❖ Software Reliability Growth Models (SRGMs) based on NHPP, SRGMs with Error Generation/ Imperfect Debugging, Concept of Change Point, SRGMs using Stochastic Differential Equations, Unification scheme for SRGMs, Allocation and Control of Testing Effort
- ❖ Release Time Problems: When to Stop Testing Software under different criteria (cost, reliability, warranty, risk, safety), bi-criterion release policy
- ❖ Modelling Software Up-gradations, testing stop time for multi up-gradations Software Vulnerability Analysis: Problems with Definitions and Assumptions

Unit 6: Queueing Systems

- ❖ Stochastic processes and Markov chains (Discrete Time Markov Chains and Continuous Time Markov Chains), Characteristics of queueing systems; Little's formula, Markovian and non- Markovian queueing systems, Transient behaviour; Embedded Markov chain and its application to M/G/1, G/M/1, and related Queueing Systems.
- ❖ Networks, Series, and Cyclic Queues; Semi Markov and Markov renewal processes in Queueing. Design and control of queues, Fluid queues.
- ❖ Stochastic Petri Net Modelling and its application in Queueing, Applications of the theory to the performance modeling of computer and communication networks.

Unit 7: Supply Chain Management

- ❖ Introduction to supply chain network, Supply chain evaluation, Supply chain decisions- strategic, tactical and operational, Supply chain strategies- push, Pull and push-pull, Bullwhip effect supply chain evaluation and performance measures.
- ❖ Mathematical Programming models for supply chain planning, Design and optimization, Vendor buyer coordination, Production distribution coordination, Inventory distribution, Coordination and procurement distribution coordination, Reverse and closed loop supply chain, Green supply chain and Sustainability in supply chain.

Unit 8: Financial Engineering

Introduction to Financial Engineering, Financial securities- fixed-income securities, index linked securities, Derivative securities- Forwards, Futures, Swaps, Options; Arbitrage and Hedging, No Arbitrage pricing of forward and futures contracts, Bounds for option prices, put-call parity, Valuation of contingent claims, fundamental theorem of asset pricing, The Cox-Ross-Rubinstein (CRR) model.

Introduction to Stochastic Calculus – Martingale, Brownian motion, Ito process, Diffusion and stochastic differential equation, Ito's lemma; Black-Scholes PDE and Black-Scholes option pricing formula, Delta hedging and Greeks

Applications of optimization methods in finance: Linear programming models- asset pricing and arbitrage, Non-linear programming models- volatility estimation, Integer Programming models- constructing an index fund, Dynamic programming models- structuring asset backed securities, Quadratic Optimization: mean-variance portfolio selection (Markowitz model)

Suggested Books:

1. G. Cornuejols and R. Tütüncü (2007), Optimization Methods in Finance, Cambridge University Press.
2. T. J. Watsham and K. Parramore (1997), Quantitative Methods in Finance, International Thomson Business Press.
3. J. Hull (2014), Options, Futures and other Derivatives, 9th Edition, Prentice Hall.
4. D. G. Luenberger (2013), Investment Science, 2nd Edition, Oxford University Press.
5. P. Wilmott (2006), Paul Wilmott on Quantitative Finance (selected chapters), 2nd Edition, Wiley.
6. S. M. Ross (2011), An Elementary Introduction to Mathematical Finance, 3rd Edition, Cambridge University Press.
7. A. Hirsa, S. N. Neftci (2013), An Introduction to the Mathematics of Financial Derivatives, 3rd Edition, Academic Press
8. Relevant research papers

Unit 9:**Network Optimization**

Constrained Network Problems, Minimum Cost Flows- Optimality and Duality, Maximum Flow Problem, Network Simplex Method, Relaxation Methods for Network Flow Problems, Multi-Commodity Network Flow, Minimum Concave Cost Network Flow Problems, Network Flow Problems with General Nonlinear Arc Costs, Decomposition Methods, Optimal Flow in a Network with Gains, Applications-Project Management; Facility Layout and Location Problems

Suggested Books:

1. R. K. Ahuja, T. L. Magnanti and J. B. Orlin (1993), "Network Flows: Theory, Algorithms, and Applications", Prentice Hall, Inc.
2. D. Jungnickel (2013), "Graphs, Networks and Algorithms", Fourth Edition, Algorithms and Computation in Mathematics, Springer Heidelberg.
3. J. Lee (2004), "A First Course in Combinatorial Optimization", Cambridge Texts in Applied Mathematics, Cambridge University Press.
4. C. H. Papadimitriou and K. Steiglitz (1998), "Combinatorial Optimization: Algorithms and Complexity", Dover Publications Inc., N.Y.
5. Relevant Research Papers on the Selected Topics.