M. Sc. COURSE
IN
OPERATIONAL RESEARCH

TWO-YEAR FULL-TIME PROGRAMME
SEMESTERS I to IV

SCHEME OF EXAMINATION AND COURSE CONTENTS

Department of Operational Research
Faculty of Mathematical Sciences
University of Delhi
Delhi-110007
## M. Sc. OPERATIONAL RESEARCH
### SCHEME OF EXAMINATION

#### Examination 2009 and onwards

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Duration (hrs.)</th>
<th>Sem. Exam Marks</th>
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<th>Credits</th>
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<td>First Year: Semester I</td>
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<tr>
<td>Course 101</td>
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<td>Course 102</td>
<td>Inventory Management-I</td>
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<td>(a) Theory</td>
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<td>Course 204</td>
<td>Reliability &amp; Maintenance Theory</td>
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</table>
| Second Year: Semester III  
| Course 301 | Mathematical Programming-III     | 3               | 70              | 30              | 100         | 4       |
| Course 302 | Statistics-II                    | 3               | 70              | 30              | 100         | 4       |
| Course 303 | Software Reliability             | 3               | 70              | 30              | 100         | 4       |
| Course 304 | Database Management System     & Visual Programming | 3 | 50 | 20 | 70 | 4 |
| (a) Theory |                                  | 3               | 50              | 20              | 70          | 4       |
| (b) Practical |                                |                 |                 |                 | 30          |         |

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<th>Course 305</th>
<th>Any course out of the following :</th>
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<td>3</td>
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<td>Financial Management</td>
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## Examination 2011 and onwards

### Second Year: Semester IV

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<td>401-403</td>
<td>Any three of the following:</td>
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<tr>
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<td>Inventory Management-II</td>
<td>3</td>
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<td>Queueing System-II</td>
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<td>(iv)</td>
<td>Multicriteria Decision Models</td>
<td>3</td>
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<td>(v)</td>
<td>Dynamic Optimization</td>
<td>3</td>
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<td>(vi)</td>
<td>Decision Theory</td>
<td>3</td>
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<td>(vii)</td>
<td>Portfolio Management</td>
<td>3</td>
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<tr>
<td>(viii)</td>
<td>Quality Management</td>
<td>3</td>
<td>70</td>
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<td>(ix)</td>
<td>Data Warehousing and Data Mining</td>
<td>3</td>
<td>70</td>
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<td>(x)</td>
<td>A course of equivalent credit offered by another department.</td>
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**Course 404 405:** Project Work

The Project work will be taken under approved supervisors from amongst the members of the staff and the report is to be submitted for evaluation by April 30.

It will carry 200 marks.

- Project Report: 100 marks
- Viva-Voce: 50 marks
- Internal Assessment: 50 marks

**Note 1:** Each paper will carry 100 marks including 30 marks earmarked for Internal Assessment.

**Note 2:** Students will be encouraged to use relevant software, viz. INDO/LINGO/MATLAB/SPSS/Mathematica, etc. during their course of study.

**Note 3:** It is recommended that four lectures per week will be devoted to papers 101 to 104, 201 to 204, 301 to 303 & 305 and 401-403 and three lectures per week for the theory part of papers 105, 205 & 304. It is further recommended that each part of practical papers 105, 205 & 304 will be assigned two practical periods per week.
Note 4: Papers 105, 205 & 304 consists of two parts (a and b) with the following subdivision of 30 marks for Part-b:

- **Practical Examination**: 20 marks
- **Oral**: 5 marks
- **Record Book**: 5 marks

Note 5: The format and modus operandi of Internal Assessments will be decided and announced by the Department at the beginning of a semester.

**Pass Percentage, Promotion and Division Criteria and Span Period**

**PASS PERCENTAGE**

Minimum marks for passing the examination in each semester shall be 40% in each paper and 45% in aggregate of a semester.

However, a candidate who has secured the minimum marks to pass in each paper but has not secured the minimum marks to pass in aggregate may reappear in any of the paper/s of his choice in the concerned semester in order to be able to secure the minimum marks prescribed to pass the semester in aggregate.

Note: Examination for courses shall be conducted only in the respective odd and even semesters as per the Scheme of Examinations. Regular as well as Ex-Students shall be permitted to appear/re-appear/improve in courses of odd semesters only at the end of odd semesters and courses of even semesters only at the end of even semesters.

No student would be allowed to avail of more than 3 chances to pass any paper inclusive of the first attempt.

**PROMOTION CRITERIA**

A. **Semester to Semester**: Students shall be required to fulfill the promotion criteria from the first year to the second year of the Course. Within the same year, students shall be allowed to be promoted from a semester to the next semester, provided he/she has passed at least half the papers of the current semester.

B. **First year to Second year**: Admission to the second year of the M. Sc. Course shall be open to only those students who have successfully passed at least 75% papers out of the papers offered for the first year of the M. Sc. Course comprising Semester I and Semester II taken together. However, he/she will have to clear the remaining papers while studying in the second year of the M. Sc. Course.
DIVISION CRITERIA

Successful candidates will be classified on the basis of the combined results of first year and second year examinations as follows:

- Candidates securing 60% and above: I Division
- Candidates securing 50% and above but less than 60%: II Division
- Candidates securing 45% and above but less than 50%: Pass

SPAN PERIOD

No students shall be admitted as a candidate for the examination for any of the Years/Semesters after the lapse of 4 years from the date of admission to the first year of the M. Sc. Programme.
M. Sc. OPERATIONAL RESEARCH

Semester I: Examination 2009 and onwards

Course -101: Mathematical Programming-1


Suggested Readings:

Course-102: Inventory Management-I

Analytical structure of Production and Inventory problems. Inventory related costs. Properties of Inventory systems. Factors influencing inventories. Inventory classification and its use in controlling inventory. Concept of Lead time, safety stock and service level.
Deterministic inventory models and extensions without and with lead time. Inventory models with partial backlogging and lost sales. Inventory models with constraints. Quantity discounts: All units and incremental. Models with continuous production and non-constant demand with known production capacity.

Stochastic Inventory Models and Extensions without and with lead time. Power demand pattern Inventory Model.

Introduction to Just in Time (JIT) and Vendor Managed Inventory (VMI).

Suggested Readings:


Course-103: Queueing System-I

Queueing Systems. Probability Distribution of Arrival and Service Times.
Markovian Queueing Systems: M/M/1, M/M/C, Finite Source queues. Erlangian Queueing Systems: M/E_k/1 and E_k/M/1. Bulk Queueing Systems. Basic Idea of Priority Systems. Imbedded Markov Chain Models: M/G/1, G/M/1, M/D/C.

Design and Control Problems in Queueing Theory.
Simulation Procedures: Data Generation and Book-Keeping.

Suggested Readings:


Course: Statistics-I

Probability: Probability Axioms, Conditional Probability and Bayes’ Theorem.


Discrete and Continuous Distributions.

Weak Law of Large Numbers, Central Limit Theorem.

Concepts of Random Sampling, Sample Characteristics, Exact Sampling Distributions: Chi-Square, t, F Distributions.


Suggested Readings:


Course-105: C++ & Unix

Introduction to Computer Systems. Fundamental concepts of Operating system, networking.


Suggested Readings:


Course-(b): Practical based on C++ involving OR problems
Semester II: Examination 2010 and onwards

Course – 201: Mathematical Programming-II


Applications of Integer and Quadratic Programming.

Suggested Readings:


Course-202: Scheduling Techniques

Capacitated transshipment model. Facility location models.


Sequencing problem. Flow shop problem and general n/m job-shop problem.

Suggested Readings:


Course-203: Marketing Management


Promotional decisions in the presence of competition. Game theory models for Promotional Effort. Spatial Allocation of Promotional Effort, Media Allocation of Advertisement, Brand Switching Analysis.

Sales Response to Advertising in Presence of Competition.

Channels of distribution, Transportation decision, Locating company’s wholesale dealers and warehouses.
Suggested Readings:


Course-204: Reliability & Maintenance Theory


System Reliability: Reliability of Series, Parallel, Standby, k-out-of-n, Series-Parallel, Parallel-Series configurations and Bridge Structure.

Reliability models of non-maintained & maintained systems, Availability theory and its modelling for various configurations.


Suggested Readings:


Course-205 : Java Programming

Introduction to Java Programming. Basic Syntax & Structures, Applets, Control Structures, Methods, Arrays, Strings, Object Oriented Programming Concepts (Objects, Classes, Inheritance), GUI Component (Panels and Frames), Multimedia (Sound, Graphics, Images and Animation), Error and Exception Handling, Multithreading and Input/Output Streams.

Software Packages for Operational Research Techniques.

Suggested Readings:

Course- (b) Practical using Java and OR Software Packages

Semester III: Examination 2010 and onwards

Course-301 : Mathematical Programming-III


Suggested Readings:

Course - 302 : Statistics-II


Time Series Methods: Decomposition, Exponential Smoothing Methods.


Suggested Readings:
Course-303: Software Reliability

Introduction to Software Development. Software life cycle models, software verification, validation, and testing. Error, Failure and faults in software. Concept of Perfect and Imperfect Debugging.


Introduction to commercial-off-the-shelf (COTS) software. Optimization models for COTS software.

Release time problems and testing effort allocation problem.

Suggested Readings:


Course-304: Database Management System & Visual Programming


Suggested Readings:

Part-(b) Practical based on (a)

Course-305: Any course out of the following

(i): A course of equivalent credit offered by another department.

(ii): Financial Management


Financing Decision: Problems of determining optimal capital structure, Leasing, Debt Management, Analysis of commitment of funds and risk of cash insolvency; Receivables and Inventory Management Approaches.
Suggested Readings:


(iii) Logistics & Supply Chain Management


Suggested Readings:

Semester IV: Examination 2011 and onwards

Any three courses out of the following

Course 401-403 (i): Marketing Research

Marketing Research and its objectives: Applications of Marketing Research: Advertising Research, Product Research, Sales Research. Planning the research design, Exploratory descriptive research, experimental research.


Suggested Readings:


Course-401-403 (ii): Inventory Management-II

Dynamic Inventory Models: Probabilistic Reorder Point Inventory Models without and with Lead Time. Two bin (S,s) Inventory Policy. Distribution Free Analysis. Minimax


Material Management: Value Analysis. Store Control, Purchasing Function, Codification and Standardization.

Suggested Readings:


Course-401-403 (iii): Queueing System -II

Probability Distribution of Phase Type, Quasi Birth and Death Processes, G/PH/1 Queueing Models and their Algorithmic Solutions.

Combinatorial Method and Its Applications in Queueing Theory.


Queueing Networks with Blocking. Different Numerical Methods for their Solutions, Two Nodes Open Network with Blocking.

Suggested Readings:


Course-401-403 (iv): Multicriteria Decision Models


Suggested Readings:

Course-401-403 (v): Dynamic Optimization


Suggested Readings:


Course-401-403 (vi): Decision Theory

Modeling of Decision Problems.

Decision Analysis under Risk-Probability: Decision Analysis without Sampling, Decision Analysis with Sampling.


Decision Trees and Sequential Decision Making

Suggested Readings:

Course-401-403 (vii) : Portfolio Management


Suggested Readings:
Course-401-403 (viii) : Quality Management

Overview of quality, history of quality, competitive advantage, industrial perspective, total quality system, Taguchi "Loss Function" concept.

Meaning and significance of statistical process control (SPC)-construction of control charts for variables and attributes. Acceptance sampling plans. Process capability-meaning, significance, and measurement. Six-sigma concepts of process capability. DMAIC and DMADV.

Pareto Analysis, Ishikawa (Cause/Effect) Diagrams, Failure Modes and Effects Analysis, Program for Quality Improving.


Introduction to Total Quality Management (TQM).

Suggested Readings:

Course-401-403 (ix) : Data Warehousing and Data Mining


Suggested Readings:


Course-401-403 (x): A Course of equivalent credit offered by another department.

Course 404-405 : Project Work