Choice Based Credit System (CBCS)

UNIVERSITY OF DELHI

DEPARTMENT OF OPERATIONAL RESEARCH

UNDERGRADUATE PROGRAMME
(Courses effective from Academic Year 2015-16)

SYLLABUS OF COURSES TO BE OFFERED

General Elective Operational Research papers for students of B.Sc. (Hons.)/B.A. (Hons.)

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Undergraduate Programme Secretariat

Preamble

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system. However, due to lot of diversity in the system of higher education, there are multiple approaches followed by universities towards examination, evaluation and grading system. While the HEIs must have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching–learning methods, there is a need to devise a sensible system for awarding the grades based on the performance of students. Presently the performance of the students is reported using the conventional system of marks secured in the examinations or grades or both. The conversion from marks to letter grades and the letter grades used vary widely across the HEIs in the country. This creates difficulty for the academia and the employers to understand and infer the performance of the students graduating from different universities and colleges based on grades.

The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity, in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated these guidelines.

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
2. **Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.
   - **2.1 Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).
   - **2.2 Dissertation/Project**: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.
   - **2.3 Generic Elective (GE) Course**: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.
     P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.
3. **Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course:** The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.
   - **3.1** AE Compulsory Course (AECC): Environmental Science, English Communication/MIL Communication.
   - **3.2** AE Elective Course (AEEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

Details of courses under B.A (Honors), B.Com (Honors) & B.Sc. (Honors)

Course	*Credits	
	Theory+ Practical	Theory + Tutorial
I. Core Course		
(14 Papers)	14X4= 56	14X5=70
Core Course Practical / Tutorial*		
(14 Papers)	14X2=28	14X1=14
II. Elective Course		
(8 Papers)		
A.1. Discipline Specific Elective	4X4=16	4X5=20
(4 Papers)		
A.2. Discipline Specific Elective		
Practical/ Tutorial*	4 X 2=8	4X1=4
(4 Papers)		
B.1. Generic Elective/		
Interdisciplinary	4X4=16	4X5=20
(4 Papers)		
B.2. Generic Elective		
Practical/ Tutorial*	4 X 2=8	4X1=4
(4 Papers)		

- **Optional Dissertation or project work in place of one Discipline Specific** E**lective paper (6 credits) in 6th Semester**

III. Ability Enhancement Courses		
1. **Ability Enhancement Compulsory**		
(2 Papers of 2 credit each)	2 X 2=4	2 X 2=4
Environmental Science		
English/MIL Communication		
2. **Ability Enhancement Elective** (Skill Based)		
(Minimum 2)	2 X 2=4	2 X 2=4
(2 Papers of 2 credit each)		
Total credit	**140**	**140**

Institute should evolve a system/policy about ECA/ General Interest/Hobby/Sports/NCC/NSS/related courses on its own.

*** wherever there is a practical there will be no tutorial and vice-versa**

Generic Elective: Course (GE)

GE1 Introduction to Operational Research and Linear Programming (Theory and practical)

GE2 Inventory Management (Theory and practical)

GE3 Queueing and Reliability Theory (Theory and practical)

GE4 Integer Programming and Theory of Games (Theory and practical)

GE 1: Introduction to Operational Research and Linear programming

Origin & Development of OR, Different Phases of OR study, Methodology of OR, Scope and Limitations of OR, OR in decision making, Applications of OR.

Linear Programming: Linear combination of vectors, Linearly independent / dependent vectors, Basis of a vector space, Convex set and its properties, Extreme points. General Linear programming problem (LPP), Standard and canonical form of LPP. Formulation of LPP, Graphical solution. Simplex method, Artificial variable techniques- Two Phase Method; Charnes M Method, Special cases in LPP. Finding Inverse of a matrix using Simplex method, Solving system of linear equations using Simplex method.

Duality: Definition of the dual problem, Primal-dual relationships, Economic Interpretation of Duality, Dual simplex Method.

Sensitivity analysis: Shadow Price, Graphical and simplex method based approach for changes in cost and resource vector.

References/Suggested Readings:

1. G. Hadley: Linear Programming. Narosa, 2002 (reprint).
2. A. Ravindran, D. T. Phillips and James J. Solberg: Operations Research- Principles and Practice, John Wiley & Sons, 2005.
3. Hamdy A. Taha: Operations Research-An Introduction, Prentice Hall, 9th Edition, 2010.
4. F.S. Hillier. G.J. Lieberman: Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata McGraw Hill. 2010.

Practical/Lab to be performed on a computer using OR/Statistical packages

1. To solve Linear Programming Problem using Graphical Method with
    (i) multiple constraints
    (ii) Unbounded solution
    (iii) Infeasible solution
    (iv) Alternative or multiple solution
2. Solution of LPP with simplex method.
3. Solution of LPP with unrestricted variables through Simplex method.
4. Problem solving using M-Charnes method.
5. Problem solving using Two Phase method.
6. Illustration of following special cases in LPP using Simplex method
    (i) Unrestricted variables
    (ii) Unbounded solution
    (iii) Infeasible solution
    (iv) Alternative or multiple solution
7. Problems based on Dual simplex method.
8. Problems based on sensitivity analysis.

GE 2: Inventory Management

Introduction to inventory systems, Different costs in inventory system, Selective inventory classification (VED, XML, FNSD, ABC) and its use in controlling inventory.

Deterministic continuous review models: Basic Economic order quantity (EOQ) model (with and without shortages), EOQ with finite supply (with and without shortages), EOQ with backorders, Determination of reorder point for all the models. Multi-item EOQ model with constraints, All-unit quantity discount model.

Probabilistic inventory models: Single period probabilistic inventory models with discrete and continuous demand.

References/Suggested Readings:

1. Donald Waters: Inventory Control, John Wiley, 2010.
2. F.S. Hillier and G.J. Lieberman: Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata McGraw Hill, 2010.
3. G. Hadley, T. M. Whitin: Analysis o f Inventory- Systems, D. B. Taraporevala and Sons, Published by arrangement with Prentice Hall Inc., 1979.
4. Buffa, Elwood S. and Sarin Rakesh K., Modern Production / Operations Management, 8th Edition, Wiley India, 2009.

Practical/Lab to be performed on a computer using OR/Statistical packages

1. Problems based on selective inventory classification. (ABC and FNS analysis)
2. To find optimal inventory policy for EOQ model.
3. To find optimal inventory policy for EOQ model with finite supply.
4. To find optimal inventory policy for EOQ model with backorders.
5. To solve EOQ model with constraints.
6. To solve All-units quantity discounts model.
7. To find optimal inventory policy for Probabilistic inventory model with discrete demand.
8. To find optimal inventory policy for Probabilistic inventory model with continuous demand.

GE 3: Queuing and Reliability Theory

Queuing Theory: Basics of queuing system, Kendall's notation, performance measures, Little's formula, Birth-death process, Markovian models: - Single server with finite and infinite capacity, multi servers' queues.

Reliability Theory: Basics of reliability, hazard rate, mean time before failure (MTBF), failure time distribution functions, reliability of configurations- series, parallel, mixed configuration, k out of n system and standby system, Reliability and Availability models, Time dependent and independent Replacement policies, Concepts and definitions of Preventive Maintenance, Corrective Maintenance and Age Replacement.

References/Suggested Readings:

1. F.S. Hiller and G.J. Lieberman: Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata McGraw Hill, 2010.
2. D. Gross, John F. Shortle, James M. Thompson and C. Harris, Fundamentals of Queuing Theory, 4th Edition, Wiley India, 2008.
3. Srinath. L. S., Reliability Engineering, East West Press, New Delhi, 2005.
4. Trivedi K.S., Probability and Statistics with reliability, Queuing and Computer Science Applications, Prentice-Hall of India, New Delhi, 2011.
5. John G. Rau, Optimization and Probability in Systems Engineering, V. N. Reinhold Co. 1970.

Practical/Lab to be performed on a computer using OR/Statistical packages

1. To determine the performance measures for M/M/1 queuing model.
2. To determine the performance measures for M/M/1/N queuing model.
3. To determine the performance measures for M/M/C/∞ queuing model.
4. To determine the performance measures for M/M/C/N queuing model.
5. Problems based on Simulation: Random number generation.
6. Problems based on Monte Carlo method.
7. Calculation of hazard rate, MTBF for series & parallel system
8. Calculation of hazard rate, MTBF for Mixed configuration.
9. Problems based on reliability optimization.

GE 4: Integer Programming and Theory of Games

Integer Programming Problem (IPP): Pure and mixed IPP, Methods for solving IPP: Branch & Bound method, Gomory's cutting plane method. Applications of IPP.

Theory of Games: Introduction to Game theory, Formulation of two-person zero-sum rectangular game; Solution of rectangular games with saddle points; dominance principle; rectangular games without saddle point – mixed strategy, Graphical, algebraic and linear programming solution of m x n games.

References/Suggested Readings:

1. Hamdy A. Taha : Operations Research-An Introduction, Prentice Hall, 9th Edition, 2010
2. P. R. Thie and G. E. Keough: An Introduction to Linear Programming and Game Theory, Wiley, New Jersey, 3rd edition, 2008.
3. F.S. Hillier and G.J. Lieberman: Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata McGraw Hill, 2010.

Practical/Lab to be performed on a computer using OR/Statistical packages

1. Solution of IPP using Branch and Bound method.
2. Solution of IPP using Gomory's cutting plane method.
3. Solution of Capital Budgeting Problem.
4. Solution of Fixed charge problem.
5. Solution of cargo loading problem.
6. Solution of production planning problem.
7. Solution of Two-Person Zero-Sum pure and mixed strategy game.
8. Linear programming solution of game problem.