



UNIVERSITY OF DELHI

Delhi-110007

No.SPA/R/011/5383

Dated: May 9, 2011

REGISTRAR

NOTIFICATION

It is notified that the Academic Council in its special meeting held on April 25, 2011 has approved the semester based syllabi of the following courses, to be implemented from the Academic session 2011-2012:

| |
|--|
| B.A. (Hons.) in Arabic |
| B.A. Programme (Discipline Courses) in Arabic |
| B.A. Programme (Compulsory Language Courses) in Arabic |
| B.A. Programme (Discipline Courses) in Buddhist Studies |
| B.A. (Hons.) in Bengali |
| B.A. Programme (Compulsory Language Course (Assamese, Bengali, Gujarati, Kannada, Manipuri, Oriya, Sindhi, Tamil and Telugu. |
| B.A. Programme (Discipline Courses (Assamese, Bengali, Gujarati, Kannada, Manipuri, Oriya, Sindhi, Tamil and Telugu) |
| B.A. (Hons.) in Hindi |
| B.A. (Hons.) in Hindi Patrakarita evam Jansanchar |
| B.A. Programme (Discipline Courses) in Hindi |
| B.A. Programme (Language Courses) in Hindi |
| B.A. (Hons.) in Urdu |
| B.A. Programme (Discipline Courses) in Urdu |
| B.A. Programme (Language Courses) in Urdu |
| B.Com. Programme (Language Courses) in Urdu |
| B.A. Programme (Discipline Courses) in Linguistics |
| B.Sc. (Hons.) in Statistics |
| B.A. Programme (Discipline Courses) in Statistics |
| B.A. Programme (Discipline Courses) in Operational Research |
| B.A. (Hons.) in Tabla/Pakhawaj |
| B.A. (Hons.) in Hindustani/Karnatak Music (Vocal/Instrumental) |
| B.A. Programme (Discipline and Application Courses) in Music |
| B.A. (Hons.) in Persian |
| B.A. Programme (Discipline & Language Courses) in Persian |
| B.A. (Hons.) in Philosophy |
| B.A. Programme (Discipline Courses) in Philosophy |
| B.Com. and B.Com. (Hons.) (Compulsory Language Courses) In Punjabi |
| B.A. (Hons.) in Punjabi |
| B.A. Programme (Discipline Courses) in Punjabi |
| B.A. Programme (Compulsory Language Courses) in Punjabi |

| | |
|---|--|
| B.A. (Hons.) in Sanskrit | |
| B.A. Programme (Discipline Courses) in Sanskrit | |
| B.A. Programme (Compulsory Language Courses) in Sanskrit | |
| B.A. (Hons.) in Psychology | |
| B.A. (Hons.) in Applied Psychology | |
| B.A. Programme (Discipline Courses) in Psychology | |
| B.Sc. (Hons.) in Mathematics | |
| B.A. Programme (Discipline Courses) in Mathematics | |
| B.A. Programme (Application Courses) in Mathematics | |
| B.Sc. Mathematical Sciences | |
| B.Sc. (Hons.) in Computer Science | |
| B.A. Programme (Application and Discipline Courses) in Computer Science | |
| B.Com. (Hons.) | |
| B.Com. | |
| B.A. Programme (Discipline Courses) in Commerce | |
| B.P.Ed. | |
| B.Sc. in Physical Education, Health Education & Sports. | |
| B.A. Programme (Discipline Courses) in Physical Education | |
| B.A. Programme (Application Courses) in Physical Education | |
| B.Sc. (Hons.) in Polymer Science | |
| B.A. Programme (Discipline Courses) in Home Science | |
| Bachelor of Fine Arts (B.F.A.) | |
| B.A. Programme (Application and Foundation Courses) | |

Further, the Academic Council has resolved that "in order to implement the semesterization of syllabi of those under-graduate courses of study which have not yet been received from the Faculties, the Academic Council authorizes the Vice-Chancellor to take all necessary measures as the Vice-Chancellor may deem fit (including bifurcation of the current existing syllabi, if required) for their implementation from the academic session 2011-2012." The syllabi of these courses shall be sent to you in due course prior to the commencement of the academic session 2011-2012.

Ras
9.5.11
REGISTRAR

Copy to:

1. Deans of the Faculties
2. Heads of the Departments
3. Principals of the Colleges

STRUCTURE OF B.SC. MATHEMATICAL SCIENCES

Semester (2011- onwards) (Academic Council Resolution No. 3(17) dated 25.04.2011)

- (a) Six papers of Mathematics are compulsory, one in each semester.
- (b) Six papers each from two of the following three disciplines: Statistics, Operational Research, Computer Science.
- (c) Two concurrent papers from the discipline not chosen in (b) above.
- (d) Four Credit Courses I - IV as offered in B.Sc. (H) Mathematics.

SEMESTER – I

| | |
|-----------------|---------------------------------|
| Paper 1 | Maths – I |
| Paper – 2, 3, 4 | OR-I, CS-I, Conc. Stats-I |
| | or CS-I, Stats-I, Conc. OR-I |
| | or Stats-I, OR-I, Conc. CS-I |

SEMESTER – II

| | |
|-----------------|------------------------------------|
| Paper 5 | Maths – II |
| Paper – 6, 7, 8 | OR-II, CS-II, Conc. Stats-II |
| | or CS-II, Stats-II, Conc. OR-II |
| | or Stats-II, OR-II, Conc. CS-II |

SEMESTER – III

| | |
|--------------------|-------------------------------------|
| Paper 9 | Maths – III |
| Paper – 10, 11, 12 | OR-III, CS-III, & Credit-I |
| | or CS-III, Stats-III, & Credit-I |
| | or Stats-III, OR-III, & Credit-I |

SEMESTER – IV

| | |
|--------------------|------------------------------------|
| Paper 13 | Maths – IV |
| Paper – 14, 15, 16 | OR-IV, CS-IV, & Credit-II |
| | or CS-IV, Stats-IV, & Credit-II |
| | or Stats-IV, OR-IV, & Credit-II |

SEMESTER – V

| | |
|-------------------|-----------------------------------|
| Paper 17 | Maths – V |
| Paper –18, 19, 20 | OR-V, CS-V, & Credit-III |
| | or CS-V, Stats-V, & Credit-III |
| | or Stats-V, OR-V, & Credit-III |

SEMESTER – VI

| | |
|--------------------|------------------------------------|
| Paper 21 | Maths – VI |
| Paper – 22, 23, 24 | OR-VI, CS-VI, & Credit-IV |
| | or CS-VI, Stats-VI, & Credit-IV |
| | or Stats-VI, OR-VI, & Credit-IV |

Note: Maths – Mathematics
OR – Operational Research
CS – Computer Science
Stats – Statistics
Conc. - Concurrent

B.Sc. Mathematical Sciences

ANNUAL

Module 101: Calculus and Matrices

Unit 1: Matrices (20 L)

\mathbb{R}, \mathbb{C} as vector spaces over \mathbb{R} . Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of $\mathbb{R}^2, \mathbb{R}^3$. Translation, Reflection in a point, line and plane. Matrix form of basic geometric transformations. Interpretation of eigenvalues and eigenvectors for such transformations. Invariant subspaces as invariant subspaces. Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3. Computation of matrix inverses using elementary operations. Rank of matrix. Solutions of a system of linear equations using matrices. Illustrative examples of above concepts from Geometry, Physics, Chemistry, Life Sciences.

Unit 2: Calculus (34 L)

Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. Series arising from Tower of Hanoi game, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits. Convergence of a sequence of real sequences. Illustration of proof of convergence of some simple sequences such as $(-1)^n/n, 1/n^2, (1+1/n)^n, \sin n/n, \cos n/n$, an with $y = 1$. Graphs of simple functions as trigonometric, exponential, logarithmic and hyperbolic functions arising in problems of chemical reaction, simple pendulum, rate of cooling/heating problem and biological rhythms. Successive differentiation. Leibnitz theorem. Recursion formulae for higher derivative. Functions of two variables and Level Curves of functions of two variables. Partial differentiation upto second order. Computation of Taylor's Maclaurin's series of functions such as $e^x, \sin x, \cos x$. Their use in polynomial approximation and error estimation. Formation and solution of Differential equations arising in population growth, radioactive decay, distribution of medicine and cell division.

Unit 3: Complex Numbers (L14)

Arithmetic representation of addition, subtraction, multiplication and division of complex numbers. Lines, half planes, circles, discs in terms of complex variables. Fundamental Theorem of Algebra and its consequences, De Moivre's theorem for rational indices and its simple applications.

Suggested Readings:

1. George B. Thomas, Jr., Ross L. Finney : Calculus and Analytic Geometry, Pearson Education (Singapore); 2001.
2. T. A. Apostol : Calculus, vol. 1, John Wiley and Sons (Asia) : 2002.
3. A. I. Kostin : Introduction to Algebraic Equations, Springer, 1981.

Using computer aided software for example, Matlab/ Mathematica/ Maple/ MuPad/ wxMaxima for operations of complex numbers, plotting of complex numbers, operations of matrices, determinant, rank, eigenvalue, eigenvector, inverse of a matrix, solution of system of equations

BS

Paper 7

MAPT-202: Calculus and Geometry

Unit I: Calculus 44

Limit and continuity of a function: $\epsilon\delta$ and sequential approach. Properties of continuous functions including intermediate value theorem. Differentiability, D. Rolle's theorem. Lagrange's mean value theorem. Cauchy mean value theorem with geometrical interpretations. Uniform continuity. Definitions and techniques to spot singular points, concavity, convexity, points of inflexion for functions. Tracing of standard curves. Integration of irrational functions. Reduction of Quadrature. Volumes.

Unit III: Geometry and Vector Calculus 24

Techniques for sketching parabola, ellipse and hyperbola. Reflective properties of parabola, ellipse and hyperbola. Classification of quadratic equations: ellipse and hyperbola. Differentiation of vector valued functions, gradient, divergence, curl and their geometrical interpretation. Spheres, Cylindrical surfaces, graphing standard quadric surfaces like cone, ellipsoid.

Recommended Books

1. I. Anton, I. Bivens and S. Davis: *Calculus*, John Wiley and Sons (Asia) Pte, Ltd. 2007.
2. R.G. Bartle and D.R. Sherbert : *Introduction to Real Analysis* , John Wiley and Sons (Asia) Pte, Ltd: 1982

Use of computer aided software for example, *Mathlab/ Mathematical Maple/ MuPAD/ wxMaxima* in identifying the singular points, points of inflection and *trac*.

Semester II

PS

1. To determine the Coefficient of Thermal Conductivity of Copper by ~~Reade's~~ apparatus.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
3. To determine the Temperature Coefficient of Resistance (α) by Platinum Resistance Thermometer (PRT). Assume $R_t = R_0(1 + \alpha t)$
4. To draw a calibration curve for a Thermocouple using a Potentiometer.
5. To determine Stefan's Constant.
6. To determine wavelength of sodium light using Fresnel Biprism.
7. To determine wavelength of sodium light using Newton's rings.
8. To determine the Cauchy's constant and dispersive power of a prism using mercury light.
9. To determine the wavelength of Sodium light using plane diffraction grating.
10. To study the polarization of light by reflection and to determine the polarizing angle for air-glass interface.

Recommended Books for Reference

1. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.
2. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
3. Nelson and Jon Ogborn, Practical Physics.

paper 14

LAPY 303- Algebra

group; Definition and examples of groups, examples of abelian and nonabelian groups, the group Z_n of integers under addition modulo n and the group $U(n)$ of multiplication modulo n , Cyclic groups from number systems, complex roots of unity, circle group, the general linear group $GL_n(\mathbb{R})$, groups of symmetries of (i) an equilateral triangle (ii) a rectangle, and (iv) a square; the permutation group $Sym(n)$, Group of quaternions, Subgroups, cyclic subgroup, the

RD

1. To verify the Thevenin, Norton, Superposition, and maximum power transfer theorem.
2. To determine a low resistance by Carey Foster's bridge.
3. To determine the (a) current sensitivity, (b) charge sensitivity, and (c) CDR of a B.C.
4. To determine high resistance by leakage method.
5. To determine the ratio of two capacitances by De Saury's bridge.
6. To determine self inductance of a coil by Anderson's bridge using AC.
7. To determine self inductance of a coil by Rayleigh's method.
8. To determine coefficient of Mutual inductance by absolute method.

Suggested Books for Reference

1. *B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi.*
2. *Indu Prakash and Ramkrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.*
3. *Nelson and Jan Ogborn, Practical Physics.*

Paper 15

M/APT-404: Differential Equations

5

Ordinary Differential equations

First order exact differential equations. Integrating factors, rules to find and integrating factor. First order higher degree equations. Methods for solving ordinary differential equations. Methods for solving ordinary differential equations. Basic theory of linear differential equations. Wronskian, and its properties. Solving an differential equation by reduction of order. Higher order linear differential equations with constant coefficients. Linear non-homogeneous equations. The method of variation of parameters. Simultaneous differential equations. Total differential equations. Applications of differential equations: the vibrations of a mass on a spring, mixture problem, flow through a network, forced mechanical systems, electric circuit problem, mechanics of simultaneous differential equations.

Partial Differential Equations

Order and degree of partial differential equations. Concept of linear and non-linear partial differential equations. Formation of first order partial differential equations. First order partial differential equations. Charpit's method. Classification of second order partial differential equations into elliptic, parabolic and hyperbolic. Group theory. Applications to Traffic Flow. Using Computer aided software for example, *Mathlab Mathematics Adapter: Maple: Maple-Characteristics, Substituting, etc.*

Recommended Books

- Shepley L. Ross: *Differential equations*, Third edition, John Wiley and Sons, 1984
- G. S. Suddon: *Elements of partial differential equations*, McGraw-Hill, International Edition, 1967.

BSZ

9. Atomic Physics by J.H. Fewkes & John Yarwood, Vol. 1 (Oxford Univ. Press, 1991).
10. E. Merzbacher, Quantum Mechanics, 3rd edition, (John Wiley & Sons, Inc 1997)

PHYSICS LABORATORY

1. To determine e/m of electron by Bar Magnet or by Magnetic Focusing.
2. To determine the wavelengths of Hydrogen spectrum and hence to determine the value of Rydberg's Constant.
3. To draw the BH curve of iron by using a Solenoid and to determine the energy loss due to Hysteresis.
4. To study the PE Hysteresis loop of a Ferroelectric Crystal.
5. To determine the Hall Coefficient and the Hall angle of a Semiconductor.
6. To study the Resistivity of a Cr Crystal with temperature by Four-Probe Method and hence to determine the Band Gap E_g for it.
7. To determine the Wavelength and the Velocity of Ultrasonic Waves in a liquid (kerosene oil, xylene, etc.) by studying the Diffraction of light through an LI
8. To determine the Specific Rotation of cane sugar using Polarimeter.
9. To analyze Elliptically Polarized Light.
10. To determine the Wavelength and the Angular Spread of a He-Ne laser.

Suggested books for references:

1. Nelson and Jon Dugborn, Practical Physics.
2. Worsnop and Flint: Advanced Practical Physics

paper 19

APT-505: Real Analysis

emphasis is on visual ideas of convergence and divergence and series expansions of elementary functions.

AS

Unit I : Real Sequences (30 L)

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, statement of order completeness property of \mathbb{R} . Archimedean property of \mathbb{R} , intervals. Concept of cluster points and statement of Bolzano Weierstrass' theorem. Cauchy convergence criterion for sequences, Cauchy's theorem on preservation and squeeze theorem, monotone sequences and their convergence.

Unit II: Infinite Series (38 L)

Infinite series, Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, Leibnitz's test, Definition and examples of absolute and conditional convergence. Sequences and series of functions, Pointwise and uniform convergence. Mean Value theorem of limits. Power Series: radius of convergence, Cauchy-Hadamard theorem, term-by-term differentiation and integration of power series. Definition in terms of $\cos(x)$ and their properties of $\exp(x)$, $\sin(x)$, $\cos(x)$.

Use of computer aided software for example, *Matlab/ Mathematical Maple/ MuPad/ wxMaxima for Taylor and Maclaurin series of $\sin x$, $\cos x$, $\log(1+x)$, e^x , $(1-x)^{-1}$, minima, inverse of graphs, sequences*

References:

Recommended Books

1. T. M. Apostol, Calculus, Volume-1, John Wiley and Sons (Asia) Pte Ltd., 2002.
2. R.G. Bartle and D. R Sherbert: *Introduction to real analysis*, John Wiley and Sons (Asia) Pte. Ltd., 2000.
3. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
4. K.A. Ross, *Elementary Analysis — The Theory of Calculus Series—*

Undergraduate Texts in Mathematics, Springer Verlag, 2003.

BSZ

Paper 23

MAPT-606: Mechanics and Discrete Mathematics

Mechanics (L 30)

Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body, Laws of friction, Problems of equilibrium under forces including friction, Work and potential energy. Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components, Newton's Laws of motion, Simple harmonic motion, Simple Pendulum, Projectile Motion.

Graph Theory (L 38)

Types of graphs : Simple graph, Directed graph, Multi graph, and Pseudo graph, Graph modeling, terminology and basics, Special Graphs : Complete Graph, Bipartite Graphs, Bipartite Graph, Complete Bipartite Graph, Subgraph and basic algebraic operations on graphs, connectivity, path, cycles, tree to be introduced as a connected graph, introduction to shortest path (least number of edges) problem, solution of shortest path problem for simple graphs using complete enumeration, Euler cycles (for undirected graphs only) : Königsburg Bridge Problem, statements and interpretations of (i) necessary and sufficient conditions for Euler cycles and path (ii) for Hamiltonian cycles, finding Euler cycles and Hamiltonian cycles in a given graph, Tree traversal, spanning trees, weighted graphs, minimal spanning tree algorithm, Prim's algorithm, Huffman codes.

Use of computer aided software for example, *Mathlab: Mathematical Maple/ MuPad/ wxMaxima for Projectile motion, Euler and Hamiltonian graphs, Königsburg Bridge Problem, Huffman codes.*

MS

Recommended Books

1. A.S. Ramsay, *Statics*, CBS Publishers and Distributors (Indian Reprint), 1998.
2. A.P. Roberts, *Statics and Dynamics with background in Mathematics*, Cambridge University Press, 2003.
3. E.H. Rosen, *Discrete mathematics and its applications*, McGraw-Hill International Editions, 1999.
4. C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis*, Pearson Education Ind. 2004.

082

Page per 24

ICT-602: Chemistry-2

Section A: Basic Organic Chemistry

(30 Lectures)

Unit 1: Fundamentals of Organic Chemistry

Concept of hybridization of carbon. Cleavage of a covalent bond: homolysis and heterolysis.

Electronic effects and their applications (inductive, electromeric, hyperconjugation and resonance). Structure and stability of reactive intermediates (carbocations, carbanions, free radicals). Relative strength of carboxylic acids (aliphatic, aromatic and halo-substituted aliphatic), alcohols, phenols and nitro-phenols. Relative basic strength of (aliphatic and aromatic) intermolecular and intramolecular forces: types of intermolecular forces and their characteristics (ion-dipole, dipole-dipole, dipole-induced dipole dispersion forces). Intermolecular and intramolecular hydrogen bonding. Effect of intermolecular and intramolecular forces on properties such as solubility, vapour pressure and boiling points of organic compounds.

Unit 2 : Stereochemistry

Conformations w.r.t. ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations. Concept of chirality (optical isomers). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *dlx* - *trax* diastereoisomers; R/S (for upto 2 chiral carbon atoms) and E/Z Nomenclature (for upto two C=C systems).

(30 Lectures)

Section B: Chemistry of Biomolecules

**SEMESTER BASED SYLLABUS FOR PAPERS IN
STATISTICS FOR THE COURSE “B.Sc.
MATHEMATICAL SCIENCES”**

| | | Duration (hrs.) | Max. Marks | Internal Assessment | |
|----------------------|----------|---|------------|------------------------|----|
| SEMESTER I | | | | | |
| PAPER | STP-101: | Descriptive Statistics and Probability | 3 | 75 | 25 |
| PRACTICAL | I | | 4 | 50 | |
| SEMESTER II: | | | | | |
| PAPER | STP-202: | Statistical Methods – I | 3 | 75 | 25 |
| PRACTICAL | II | | 4 | 50 | |
| SEMESTER III: | | | | | |
| PAPER | STP-303: | Statistical Methods – II | 3 | 75 | 25 |
| PRACTICAL | III | | 4 | 50 | |
| SEMESTER IV: | | | | | |
| PAPER | STP-404: | Applied Statistics | 3 | 75 | 25 |
| PRACTICAL | IV | | 4 | 50 | |
| SEMESTER V: | | | | | |
| PAPER | STP-505: | Statistical Inference | 3 | 75 | 25 |
| PRACTICAL | V | | 4 | 50 | |
| SEMESTER VI: | | | | | |
| PAPER | STP-606: | Sample Surveys and Design of Experiments | 3 | 75 | 25 |
| PRACTICAL | VI | | 4 | 50 | |

Two Papers of Statistics (Concurrent)
(for those who have not chosen Statistics as part of the programme)

| | | | | | |
|----------------------|----------|----------------------------------|---|----|----|
| SEMESTER III: | | | | | |
| PAPER | STC-301: | Basic Statistics and Probability | 3 | 75 | 25 |
| SEMESTER IV: | | | | | |
| PAPER | STC-402: | Statistical Methodology | 3 | 75 | 25 |

- Note 1:** For each theory paper there shall be 5 lecture periods including one period for students' presentations/group interactions. Besides, there will be tutorial work (as per the University guidelines) relating to those theory papers as are not covered under Practicals.
- Note 2:** In view of the depth and wide ranging coverage of Practicals based on real life data, it is desired that 3 sittings of 2 periods each per week be enforced for Laboratory work based on Practicals I, II, III, IV, V and VI.
- Note 3:** There will be one batch of 15 students for practical classes.
- Note 4:** The conduct and evaluation in respect of the Examination relating to the Practical Papers would be as per the general guidelines laid down by the University.
- Note 5:** In respect of Practicals I, II, III, IV, V and VI, carrying 50 marks each, 10 marks will be allocated to the class record and 10 marks to the oral test.
- Note 6:** The 25% marks for Internal Assessment will be distributed in the following manner:
- (a) Attendance: 10%
 - (b) Assignments (at least one): 10%
 - (c) Class Tests/Project Presentation: 5%

DETAILED COURSES OF READINGS

SEMESTER I

PAPER: STP-101

Descriptive statistics and Probability

Concepts of a statistical population and sample from a population, quantitative and qualitative data, nominal, ordinal and time-series data, discrete and continuous data. Presentation of data by tables and by diagrams, frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods). Ogives.

Measures of location (or central tendency) and dispersion, moments, measures of skewness and kurtosis, cumulants. Bivariate data: Scatter diagram, principle of least-squares and fitting of polynomials and exponential curves. Correlation and regression: Karl Pearson coefficient of correlation, Lines of regression, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only).

Random experiment, sample point and sample space, event, algebra of events, Definition of Probability – classical, relative frequency and axiomatic approaches to probability; merits and demerits of these approaches (only general ideas to be given). Theorems on probability, conditional probability, independent events. Bayes theorem and its applications.

SUGGESTED READINGS:

1. Freund, J.E. (2009): Mathematical Statistics with Applications, 7th Edn. (3rd Impression), Pearson Education.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics, Vol. I, 8th Edn. World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
4. Hogg, R.V., Craig, A.T. and Mckean, J.W. (2005): Introduction to Mathematical Statistics, 6th Edn. Pearson Education.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

Practical I (using MS Excel): Based on Paper STP-101.

SEMESTER II

PAPER: STP-202

Statistical Methods – I

Random variables: Discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations of random variables and its properties, expectation of random variable and its properties. Moments and cumulants, moment generating function, cumulants generating function and characteristic function. Transformation in univariate and bivariate distributions. Bivariate probability distributions; marginal and conditional distributions; independence of variates (only general idea to be given).

Point (or degenerate), Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric, Normal, Uniform, Exponential, Beta and Gamma distributions.

Statement and application of Chebychev's inequality, WLLN and SLLN. Central limit theorem (CLT) for i.i.d. variates, and its applications. De Moivre's Laplace Theorem.

SUGGESTED READINGS:

1. Goon, A.M. Gupta, M.K. and Dasgupta. B. (2003): An Outline of Statistical Theory, Vol. I, 4th Edn. World Press, Kolkata.
2. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
3. Hogg, R.V., Craig, A.T. and Mckean, J.W. (2005): Introduction to Mathematical Statistics, 6th Edn., Pearson Education.
4. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
5. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.
6. Ross, S. M. (2007): Introduction to Probability Models, 9th Edn., Indian Reprint, Academic Press.

Practical II: Based on paper STP-202.

SEMESTER III

PAPER: STP-303

Statistical Methods – II

Theory of attributes: consistency of data, conditions of consistency, independence and association of attributes, measure of association and contingency

Sampling Distributions: Definitions of random sample, parameter and statistic, sampling distribution of a statistic, standard errors of sample mean, sample proportion and sample moments, sampling distribution of sample mean and sample variance for normal distribution. Sampling distributions of Chi-square, t and F statistics. Distribution of sample correlation coefficient r when $\rho = 0$.

Tests of significance: Null and alternative hypotheses, level of significance and probabilities of Type I and Type II errors, critical region and power of test. Large sample tests, use of CLT for testing single proportion and difference of two proportions, single mean and difference of two means, standard deviation and difference of standard deviations. Tests of significance based on Chi-square, t and F distributions.

Order statistics: Distribution of r -th order statistic, smallest and largest order statistics.

SUGGESTED READINGS:

1. Goon, A.M. Gupta, M.K. and Dasgupta, B. (2005): An Outline of Statistical Theory, Vol. II, 3rd Edn. World Press, Kolkata.
2. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
3. Hogg, R.V. and Tanis, E.A. (1988): Probability and statistical inference, 3rd Edn. Macmillan Publishing Co., Inc.
4. Mukhopadhyay, P. (2000): Mathematical Statistics, 2nd Edn. Books and Allied (P) Ltd.
5. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.

Practical III: Based on Paper STP-303.

SEMESTER IV

PAPER: STP-404

Applied Statistics

Economic Statistics: Time Series Analysis-economic time series, different components, illustrations, additive and multiplicative models, determination of trend, analysis of seasonal fluctuations. **Index numbers**-criteria for a good index number. Different types of index numbers. Construction of index numbers of prices and quantities. Cost of living index number. Uses and limitations of index numbers.

Statistical Quality Control : Importance of statistical methods in industrial research and practice, determination of tolerance limits, general theory of control charts, process and product control, causes of variation in quality, control limits, summary of out of control criteria, charts for attributes–p-chart, np-chart, c-chart; charts for variables- \bar{X} , R and s- charts, principles of acceptance sampling, problem of lot acceptance, producer's and consumer's risks, single sampling inspection plan and its OC and ASN functions, concepts of AQL, LTPD, AOQL, ATI functions; Dodge and Romig Tables.

Demographic Methods: Sources of demographic data-census, register, adhoc surveys, hospital records, demographic profiles of Indian Census, questionnaire, errors in these data and their adjustment. Measurement of Mortality - CDR, SDR (w.r.t. age and sex), IMR, standardized death rate, complete life table, its main features and uses. Measurement of fertility and reproduction – CBR, General, Age-specific and total fertility rates, GRR, NRR.

SUGGESTED READINGS:

1. Croxton F.E. and Cowden D.J. (1969): Applied General Statistics, Prentice Hall of India.
2. Goon A.M., Gupta M.K., Dasgupta B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand and Sons.
4. Kendall, M.G. and Stuart, A. (1977): The Advanced Theory of Statistics, Vol. III, Macmillan Publishing Co., Inc.
5. Montgomery, D. C. (1996): Introduction to Statistical Quality Control, John Wiley & Sons, New York.
6. Mukhopadhyay, P. (1999): Applied Statistics. Books and Allied (P) Ltd.

Practical IV (using Statistical Software Packages): Based on Paper STP-404.

SEMESTER V

PAPER: STP-505

Statistical Inference

Estimation: Parameter space, sample space, point estimation, requirement of a good estimator, consistency, unbiasedness, efficiency, sufficiency. Minimum variance unbiased estimators. Cramer-Rao inequality (statement only). Methods of estimation: maximum likelihood, least-squares and minimum variance, statement of Rao-Blackwell theorem and Lehmann-Scheffe theorem. Properties of maximum likelihood estimators (illustration). Interval estimation : confidence intervals for the parameters of normal distribution, confidence intervals for difference of means and for ratio of variances.

Testing of Hypothesis: Statistical Hypothesis, simple and composite hypotheses. Test of statistical hypothesis, null and alternative hypotheses. Critical region. Two kinds of errors. Level of significance and power of a test. MP test and region. Neyman-Pearson lemma (statement only), Likelihood ratio test, UMP test, UMPU test, critical regions for simple hypothesis for one parameter. Non-parametric tests: One sample and two sample sign test, Wald-Wolfowitz run test, Run test for randomness, Median test and Wilcoxon-Mann-Whitney test (derivation not required , give stress on examples).

SUGGESTED READINGS:

1. Casella, G. and Berger, R.L. (2002): Statistical Inference, Second Edn. Thomson Duxbury.
2. Dudewicz, E.J., and Mishra, S.N. (1988): Modern Mathematical Statistics, John Wiley & Sons.
3. Gibbons, J. D. and Chakraborty, S. (2003): Non parametric Statistical Inference, 4th Edition, Marcel Dekker, CRC.
4. Goon, A.M. Gupta, M.K. and Dasgupta, B. (2005): An Outline of Statistical Theory, Vol. II, 3rd Edn. World Press, Kolkata.
5. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
6. Hogg, R.V. and Tanis, E.A. (1988): Probability and statistical inference, 3rd Edn. Macmillan Publishing Co., Inc.
7. Kendall, M.G. and Stuart, A. (1977): The Advanced Theory of Statistics, Vol. III, Macmillan Publishing Co., Inc.
8. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.

Practical V: Based on Paper STP-505.

SEMESTER VI

PAPER: STP-606 **Sample Surveys and Design of Experiments**

Sample Surveys: Concepts of population and sample. Complete enumeration vs. sampling. Need for sampling. Principal and organizational aspects in the conduct of a sample survey. Properties of a good estimator. Sampling and non-sampling errors.

SRSWR & SRSWOR, determination of sample size. Stratified random sampling and different allocations. Systematic sampling, comparison of known sampling strategies under linear trend. Ratio and Regression estimators and their comparison with SRSWOR estimator.

Indian Official Statistics : Present Official Statistical System in India relating to census of population, agriculture, industrial production, and prices; methods of collection of official statistics, their reliability and limitations and the principal publications containing such statistics. Also the various agencies responsible for the data collection – C.S.O., N.S.S.O., Office of Registrar General, their historical development, main functions and important publications.

Analysis of Variance and Covariance: Analysis of variance and covariance (with one concomitant variable) in one-way and two-way classified data with equal number of observations per cell.

Design of Experiments: Principles of experimentation, uniformity trials, Completely randomized, Randomized block and Latin square designs. Missing plot technique. 2^2 and 2^3 Factorial experiments: construction and analysis.

Regression Analysis : Two variable linear model – estimation , testing and problems of prediction. Precision of the estimated regression equation, interval estimation, variance estimation.

SUGGESTED READINGS:

1. Cochran, W.G. (1977): Sampling Techniques, John Wiley & Sons, New York.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8th Edn. World Press, Kolkata.
3. Goon A.M., Gupta M.K., Dasgupta B. (2005): An Outline of Statistical Theory, Vol. II, 3rd Edn. World Press, Kolkata.
4. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand and Sons.
5. Kshirsagar, A.M. (1983): A Course in Linear Models, Marcel Dekker, Inc., N.Y.
6. Montgomery, D. C. (2001): Design and Analysis of Experiments, John Wiley & Sons, New York.
7. Montgomery, D. C., Peck, E.A. and Vinning, G.G. (2006): Introduction to Linear Regression Analysis, 3rd Edn. John Wiley and Sons.
8. Mukhopadhyay, P. (1998): Theory and Methods of Survey Sampling. Prentice Hall of India.
9. Singh, D. and Chaudhary, F.S. (1995): Theory and Analysis of Sample Survey Designs. New Age International (P) Ltd.
10. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984). Sampling Theory of Surveys with Applications, Iowa State University Press, Iowa, USA

Practical VI (using C language and Statistical Software Packages): based on Paper STP-606.

Two Papers of Statistics (Concurrent)
(for those who have not chosen Statistics as part of the programme)

SEMESTER III

PAPER: STC-301

Basic Statistics and Probability

Concepts of a statistical population and sample from a population, quantitative and qualitative data, nominal, ordinal and time-series data, discrete and continuous data. Presentation of data by tables and by diagrams, frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods). Ogives.

Measures of location and dispersion, moments, measures of skewness and kurtosis, absolute and factorial moments, sheppard's correction, cumulants.

Random experiment, sample point and sample space, event, algebra of events, definition of Probability – classical, relative frequency and axiomatic approaches to probability; merits and demerits of these approaches (only general ideas to be given). Theorems on probability, conditional probability, independent events. Bayes theorem and its applications.

Random variables: Discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., expectation of random variable and its properties. moment generating function and characteristic function.

Discrete and Continuous distributions: Point (or degenerate), Binomial, Poisson, Geometric, Negative Binomial, Normal, Uniform, Exponential, Beta and Gamma.

SUGGESTED READINGS:

1. Freund J.E. (2009): Mathematical Statistics with Applications, 7th Edn. (3rd Impression), Pearson Education.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4th Edn. World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
4. Hogg, R.V., Craig, A.T. and Mckean, J.W. (2005): Introduction to Mathematical Statistics, 6th Edn., Pearson Education.
5. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.
6. Ross, S.M. (2007): Introduction to Probability Models, 9th Edn., Indian Reprint, Academic Press.

SEMESTER IV

PAPER: STC-402

Statistical Methodology

Bivariate Data: Scatter diagram, Principle of least squares and fitting of polynomial and exponential curves, Correlation and regression: Karl Pearson coefficient of correlation, lines of regression, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only).

Limit theorems: Markov's inequality, Chebyshev's inequality, weak and strong laws of large numbers, central limit theorem (Lindeberg-Levy).

Order Statistics: Distribution of r-th order statistic, smallest and largest order statistics.

Sampling Distribution: concept of random sample, parameter and statistic, sampling distribution of a statistic, standard errors of sample mean and sample proportion, sampling distribution of sample mean and sample variance for a normal population.

Hypothesis Testing: Simple, composite, null and alternative hypotheses, level of significance, two types of errors. Critical region and power of test, large sample test. Tests of significance based on chi-square, t and F statistics.

SUGGESTED READINGS:

1. Freund J.E. (2009): Mathematical Statistics with Applications, 7th Edn. (3rd Impression), Pearson Education.
2. Goon A.M., Gupta M.K. and Dasgupta, B. (2005): Fundamentals of Statistics, Vol. I, 8th Edn. World Press, Kolkata.
3. Goon A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.
4. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
5. Hogg, R.V., Craig, A.T. and Mckean, J.W. (2005): Introduction to Mathematical Statistics, 6th Edn., Pearson Education.
6. Mood, A.M. Grabill, F.A. and Boes, D.C. (2007): Introduction to the theory of Statistics, 3rd Edn. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
7. Ross, S.M. (2007): Introduction to Probability Models, 9th Edn., Indian Reprint, Academic Press.

Course Structure For Operational Research
in
B.Sc. (Mathematical Sciences)

| | | Duration hours | Maximum Marks |
|----|--|---------------------------|--------------------------|
| 1. | Linear Programming | 3 | 100 |
| 2. | Inventory and Marketing Management | 3 | 100 |
| 3. | Mathematical Programming | 3 | 100 |
| 4. | Queueing and Reliability Theory | 3 | 100 |
| 5. | Network Analysis and Theory of Sequencing | 3 | 100 |
| 6. | (a) Forecasting | 3 | 50 |
| | (b) Case Studies | | 50 |

Note : Each paper will have four lecture periods.

1. **Linear Programming**

Introduction to Operational Research and Overview of O.R. modeling. Linear independence and dependence. Convex sets. Extreme points. Hyperplanes & Polyhedral sets. Solution of a System of Linear Equations, Concept of Basis, Basic Feasible Solutions.

Introduction to Linear Programming problem. Problem formulations. Graphical Solution. Theory of Simplex Method. Two Phase Simplex Method. M-Charne's Simplex Method. Duality in Linear Programming, Economic Interpretation of Duality. Transportation problem. Assignment Problem.

Suggested Readings:

1. G. Hadley: Linear Programming, Narosa, 1987 (2002 reprint available).
2. Hamdy A. Taha: Operations Research-An Introduction, Prentice Hall, 8th Edition, 2007.
3. F.S. Hillier, G.J. Lieberman : Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata McGraw Hill, 2010.

2. **Inventory Systems and Marketing Management**

Inventory Systems:

Concepts and problems in Inventory system, Classification of Inventory systems, Different costs in Inventory system and method of their estimation. Deterministic inventory models with and without lead time and with and without shortages. Inventory models with all units Quality Discounts. Single period stochastic inventory models. Production scheduling problems.

Marketing Management:

Concept of marketing and its role in organization. Marketing decisions, scientific marketing analysis. Uses and limitations of mathematical models in marketing, Classification of market structure in competitive conditions. Demand elasticity, joint optimization of price, quality and promotional efforts. Pricing decisions, Media allocation for advertisement. Brand switching analysis.

Suggested Readings:

1. G. Hadley, T. M. Whitin: Analysis of Inventory Systems, D. B. Taraporevala and Sons, Published by arrangement with Prentice Hall Inc., 1979.
2. Zipkin: Foundations of Inventory Management, Mc-Graw Hill Inc., 2000.
3. Donald Waters: Inventory Control, John Wiley, 2003.

4. Philip Kotler : Marketing Management, 13th edition, Prentice Hall of India, 2008.
5. Tony Curtis: Marketing for Engineers, Scientists and Technologists, John Wiley & Sons Inc. 2008.
6. Graham J. Hooley and Michael K. Hassey: Quantitative Methods in Marketing, 2nd Edition, International Thomson Business Press, 1999.
7. Grahame R. Dowling: The Art and Science of Marketing- Marketing for Marketing Managers, Oxford University Press, 2005.
8. Gary L. Lilien, Philip Kotler, K. Sridhar Moorthy: Marketing Models, Prentice Hall of India, 2003.

3. Mathematical Programming

Unconstrained and constrained optimization problems. Types of extrema and their necessary and sufficient conditions. Convex functions and their properties. Kuhn-Tucker optimality conditions. Quadratic Programming. Wolfe's Method. Integer Linear Programming: Modeling using pure and mixed integer programming, Branch and Bound Technique, Gomory's Cutting Plane Algorithm.

Suggested Readings:

1. Hamdy A. Taha: Operations Research-An Introduction, Prentice Hall, 8th Edition, 2007.
2. Wayne L. Winston and M. Venkataramanan: Introduction to Mathematical Programming: Applications and Algorithms, 4th edition, Duxbury Press, 2002.
3. S. Chandra, Jayadeva, Aparna Mehra: Numerical Optimization with Applications, Narosa Publishing House, 2009.
4. A. Ravindran, D. T. Phillips and James J. Solberg: Operations Research- Principles and Practice, John Wiley & Sons, 2005.

4. Queueing and Reliability Theory

Queueing Theory:

General concepts of a queuing system, Measures of performance, Arrival and Service Processes, Single server and multi server models, channels in parallel with limited and unlimited queues – M/M/1, M/M/1/K, M/M/C, M/M/C/K, Queues with unlimited service, Finite source queues. Applications of simple queuing decision models, Design and control models.

Reliability Theory :

Basics of Reliability. Classes of life distributions. Series, parallel, standby configurations. Reliability Models. Reliability, Mean Time before failure and Hazard rate of Exponential and Weibull distributions. Concepts and definitions of preventive maintenance, corrective maintenance and age replacement.

Suggested Readings:

1. R.B. Cooper: Introduction to Queueing Theory, 2nd Edition, North Holland, 1981.
2. D. Gross, C. M.Harris: Fundamentals of Queueing Theory, 3rd Edition, John Wiley and Sons Inc. Pte. Ltd., 2002.
3. U. N. Bhat: An introduction to Queueing Theory: Modelling and Analysis in Applications (Statistics for Industry and Technology), Birkhauser Boston, 2008.
4. U. N. Prabhu: Foundations of Queueing Theory, International Series in Operations Research & Management Science, Kluwer Academic Publishers, 2nd Edition, 2002.
5. John G. Rau: Optimization and Probability in Systems Engineering, V.N. Reinhold Co., 1970.
6. Riccardo Manzini, Alberto Regattieri, Hoang Pham, Emilio Ferrai : Maintenance for Industrial Systems, Springer-Verlag, London Limited, 2010.
7. P. K. Kapur, R. B. Garg, S. Kumar: Contributions to Hardware and Software Reliability, World Scientific, Singapore, 1999.

5. Network Analysis and Theory of Sequencing

Flows in networks. Maximal flow. Shortest path and traveling salesman problem. Construction of minimal spanning tree and its applications. Project management through PERT/ CPM, Updating of PERT Charts. Project Crashing. Sequencing Problems. Processing n jobs through two/ three machines. General n/m job-shop problem.

Suggested Readings:

1. G. Hadley: Nonlinear and Dynamic Programming, Addison-Wesley, 1964.
2. A. Ravindran, D. T. Phillips and James J. Solberg: Operations Research- Principles and Practice, John Wiley & Sons, 2005.
3. R. K. Ahuja, T. L. Magnanti, B. Orlin: Network Flows-Theory, Algorithm and Applications, Prentice Hall, NJ, 1993.
4. J. D. Weist, F. K. Levy: A Management Guide to PERT/ CPM, 2nd Edition, PHI, 1967 (Reprint 2007).

6. (a) Forecasting

Introduction to Forecasting, Types of Forecast, Basic forecasting tools. Time Series and its Components. Linear and Non-linear Trend, Seasonal Variations and Irregular Variations and their Measurements. Moving Averages. Single and Double exponential smoothing.

Suggested Readings:

1. John E. Hanke, Dean Wichern and Arthur G. Reitsch. Business Forecasting, Seventh Edition (Pearson), 2008.

2. J. Holton Wilson and Barry Keating. Business Forecasting w/ Forecast, Sixth Edition (Tata McGraw Hill), 2009.
3. S.C. Gupta and V.K.Kapoor, Fundamentals of Applied Statistics, Sultan. Chand and Sons, 2009.

(b) Case Studies

The work on Case Study will start in the beginning of the sixth semester under approved supervisors from amongst the members of the staff and the case study report is to be submitted for evaluation at the end of the semester.

Course Structure For Operational Research
in
B.Sc. (Mathematical Sciences)
(Those who have not opted Operational Research)

| | Duration hours | Maximum Marks |
|-------------------------------------|---------------------------|--------------------------|
| 1. Operational Research – I | 3 | 100 |
| 2. Operational Research – II | 3 | 100 |

Note : Each paper will have four lecture periods.

Operational Research - I

Introduction to Operational Research : Definition, Different Phases, Advantages/disadvantages, Methodologies and application areas.

Concept of Basis, Basic Feasible Solutions, Convex Sets and Extreme points. Introduction Linear Programming problem. Problem formulations. Graphical Solution. Theory of Simplex Method, Two Phase Simplex Method. Duality in Linear Programming (writing Dual only), Economic Interpretation of Duality.

Concepts and problems in Inventory system, Classification of Inventory items, Different costs involved in any Inventory system and their method of estimation. General inventory models for demand known with certainty without/with lead time and without/with shortages. Inventory models with all units Quantity Discounts,

Suggested Readings:

1. G. Hadley: Linear Programming, Narosa, 1987 (2002 reprint available).
2. Hamdy A. Taha: Operations Research-An Introduction, Prentice Hall, 8th Edition, 2007.
3. F.S. Hillier, G.J. Lieberman : Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata McGraw Hill, 2010.
4. G. Hadley, T. M. Whitin: Analysis of Inventory Systems, D. B. Taraporevala and Sons, Published by arrangement with Prentice Hall Inc., 1979.
5. Zipkin: Foundations of Inventory Management, Mc-Graw Hill Inc., 2000.
6. Donald Waters: Inventory Control, John Wiley, 2003.

Operational Research - II

Integer Linear Programming: Modeling using pure and mixed integer programming, Branch and Bound Technique for all integer programming (Graphical Approach only), Transportation problem. Assignment problem, Traveling Salesman Problem.

Introduction to network analysis. Static. maximal flow. Shortest path Problem. Project management through PERT/CPM. Updating of PERT Charts. Project Crashing.

General concepts of a queuing system, Measures of performance, Arrival and Service Processes. Birth and Death queuing systems, M/M/1, M/M/1/K, M/M/C, M/M/C/K, Queues with unlimited service, Applications of simple queuing decision models.

Suggested Readings:

1. G. Hadley: Nonlinear and Dynamic Programming, Addison-Wesley, 1964.
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, 8th Edition, 2007.
4. Wayne L. Winston and M. Venkataramanan: Introduction to Mathematical Programming: Applications and Algorithms, 4th edition, Duxbury Press, 2002.
5. D. Gross, C. M.Harris: Fundamentals of Queueing Theory, 3rd Edition, John Wiley and Sons Inc. Pte. Ltd., 2002.
6. U. N. Bhat: An introduction to Queueing Theory: Modelling and Analysis in Applications (Statistics for Industry and Technology), Birkhauser Boston, 2008.
7. R. K. Ahuja, T. L. Magnanti, B. Orlin: Network Flows-Theory, Algorithm and Applications, Prentice Hall, NJ, 1993.
8. J. D. Weist, F. K. Levy: A Management Guide to PERT/ CPM, 2nd Edition, PHI, 1967 (Reprint 2007).

**Computer Science Papers for
B.Sc. (Mathematical Sciences)**

**PROGRAM (Discipline) COURSES and
CONCURRENT COURSES**

**DEPARTMENT OF COMPUTER SCIENCE
FACULTY OF MATHEMATICAL SCIENCES
UNIVERSITY OF DELHI
DELHI – 110007**

Structure

| | No.of lectures per week | Exam. Hours | Max. Marks |
|-----------|-------------------------|-------------|------------|
| Theory | 4+1 | 3 | 100 |
| Practical | 4 | 4 | 50 |

Theory Papers for Program (Discipline) courses:

CSPT 101 –Fundamentals of Programming
CSPT 202 – Data Structures
CSPT 303 – Computer System Architecture
CSPT 404 – Operating Systems
CSPT 505 - Computer Networks
CSPT 606 – Database Management Systems

Practical Papers for Program (Discipline) courses:

CSPL 101 –Fundamentals of Programming Lab: Practicals based on CSPT 101
CSPL 202 – Data Structures Lab: Practicals based on CSPT 202
CSPL 303 – Computer System Architecture Lab:Practicals based on CSPT 303
CSPL 404 – Operating Systems Lab: Practicals based on CSPT 404

CSPL 505 Computer Networks Lab:
Practicals based on CSPT 505
CSPL 606 – Database Management Systems Lab: Practicals based on CSPT 606.

Theory Papers for CONCURRENT Courses

CSCT 301 Linux System Administration
CSCT 402 Elective

Elective (i): Multimedia Systems and Applications
Elective (ii): Network and Information Security

Practical Papers for CONCURRENT Courses

CSCL 301 Linux System Administration Lab: Practicals based on CSCT 301
CSCL 402 Software Lab; Practicals based on CSCT 402

Infrastructure Recommended

Equipment:

Networked Lab with internet facility on at least 20 nodes. LCD Projection systems should be provided in Class Room/ Lab.

Software: Open Source softwares

Batch Size requirement:

Every lab session should be supervised by a teacher and the batch size should be restricted to 20. For a group of more than 20 students, the group should be divided into batches.

CSPT 101 –Fundamentals of Programming

Programming using C/ C++: Basic data types; constants and variables, arithmetic and logical expressions; input-output methods; control structures; procedural abstractions; strings and arrays; command line arguments; basic file handling; error handling.

Introduction to the object-oriented programming concepts: data abstraction and encapsulation —objects and classes; inheritance; polymorphism.

References:

1. E. Balaguruswamy, Object Oriented Programming with C++ (4th ed.), Tata McGraw Hill, 2000.
2. J. R. Hubbard, Programming with C++ (2nd ed.), Schaum's Outlines, Tata McGraw Hill, 2000.
3. B. A. Forouzan and R. F. Gilberg, Computer Science, A structured Approach using C++, Cengage Learning, 2004.
4. D S Malik, C++ Programming Language, Cengage Learning, First Indian Reprint 2009.
5. R. Albert and T. Breedlove, C++: An Active Learning Approach, Jones and Bartlett India Ltd. 2009.

CSPL 101 –Fundamentals of Programming Lab

Practicals based on CSPT 101

CSPT 202 – Data Structures

ADTs and Arrays: Single and Multidimensional arrays, Sequential Allocation

Stacks : Definition of stack, array implementation of stack, conversion of infix expression to prefix, postfix expressions, evaluation of postfix expression.

Queues : Definition of Queue, circular queues, priority queues, array implementation of queues.

Linked lists : Linked List and its implementation, Link list implementation of stack and queue, Circular and doubly linked list.

Searching and sorting: Insertion sort, selection sort, bubble sort, merge sort, Linear Search, binary search.

Trees : Introduction to trees, Binary search tree, preorder, postorder and inorder traversal.

References :

1. Nell Dale, C++ Plus Data Structure (4th Edition), Jones and Barlett 2006.
2. Data structures, Algorithms and Applications in C++ by S.Sahni, University press (India). pvt ltd / Orient Longman pvt.ltd., 2nd edition 2004.
3. Adam Drozdek, Data Structures and Algorithms in C++, Second edition, Vikas Publishing House 2004.
4. B.R. Preiss, Data structures and algorithms with object oriented design patterns in C++, John Wiley and sons, 1999.

CSPL 202 – Data Structures Lab

Practicals based on CSPT 202

CSPT 303 – Computer System Architecture

Introduction : Logic gates, boolean algebra, combinational circuits, circuit simplification, decoders, multiplexors, registers, memory units and memory hierarchy

Data Representation and basic Computer Arithmetic : Number systems, complements, fixed and floating-point representation, character representation, addition, subtraction, magnitude comparison

Basic Computer Organization and Design : Computer registers, bus system, instruction set, timing and control, instruction cycle, memory reference, input-output and interrupt, design of basic computer.

Central Processing Unit : Register organization, arithmetic and logical micro-operations, stack organization, micro programmed control; Instruction formats, addressing modes, instruction codes, machine language, assembly language, RISC/CISC architectures

Input-output Organization: Peripheral devices, I/O interface, introduction to modes of data transfer, direct memory access.

References:

1. M. Morris Mano, Computer System Architecture, 3rd edition Pearson Education, 1992.
2. William Stallings, Computer Organization and Architecture, Prentice Hall of India, 2009.
3. J. Dos Reis, Assembly language and computer architecture using C++ and JAVA, Cengage Learning, 2004.

CSPL 303 – COMPUTER SYSTEM ARCHITECTURE LAB

Practicals based on CSPT 303

CSPT 404 – Operating Systems

Introduction : System software, resource abstraction, OS strategies; Types of operating systems - multiprogramming, batch, time sharing, Operating systems for personal computers & workstations, process control & real time systems

Operating System Organization: Basic OS functions; processor modes, system calls and system programs; kernel

Process Management : System view of the process and resources, process abstraction, resource abstraction, process hierarchy, thread model; process scheduling, non-pre-emptive and pre-emptive scheduling algorithms, concurrent processes, critical section, semaphores, deadlocks

Memory Management: Physical and virtual address space; memory allocation strategies -fixed and variable partitions, paging, segmentation, virtual memory

File and I/O Management: Directory structure, file operations, file allocation methods, device management.

Protection and Security: Policy mechanism, authentication and authorization.

References:

1. Flynn/McHoes Operating Systems, Cengage Learning Third Indian Reprint 2008.
2. A.S. Tanenbaum, Modern Operating Systems, 3rd Edition, Pearson Education
3. W. Stallings, Operating Systems, 5th Edition, Prentice Hall of India 2004.
4. A Silberschatz, P.B. Galvin, G. Gagne, Operating Systems Concepts, 8th Edition, John Wiley Publications 2008.

CSPL 404 – Operating Systems Lab

Practicals based on CSPT 404 – Operating Systems

CSPT 505 Computer Networks

Basic concepts : Components of data communication, standards and organizations, Network Classification, Network Topologies ; network protocol; layered network architecture; overview of OSI reference model; overview of TCP/IP protocol suite.

Physical Layer : Cabling, Network Interface Card, Transmission Media Devices- Repeater, Hub, Bridge, Switch, Router, Gateway

Data Link Layer : Framing techniques; Error Control; Flow Control Protocols; Shared media protocols - CSMA/CD and CSMA/CA.

Network Layer : Virtual Circuits and Datagram approach, IP addressing methods – Subnetting; Routing Algorithms (adaptive and non-adaptive)

Application Layer : Application layer protocols and services – Domain name system, HTTP, WWW, telnet, FTP, SMTP

Network Security : Common Terms, Firewalls, Virtual Private Networks

References:

1. B.A. Forouzan: Data Communication and Networking, 4th Edition, Tata McGraw Hill, 2007.
2. D.E. Comer, Internetworking with TCP/IP, Vol. I, Prentice Hall of India, 1998.
3. W. Stalling, Data & Computer Communication, 8th edition, Prentice Hall of India, 2006.
4. D. Bertsekas, R. Gallager, Data Networks, 2nd edition, Prentice Hall of India, 1992.

CSPL 505 Computer Networks LAB

Practicals based on CSPT 505 Computer Networks

CSPT 606 – Database Management Systems

Introduction to Database Management Systems : Characteristics of database approach, data models, database system architecture and data independence.

Entity Relationship Modeling : Entity types, relationships, constraints, and object modeling.

Relational data model : Relational model concepts, relational constraints, relational algebra, SQL queries, programming using embedded SQL.

Database design : ER model to relational mapping, functional dependencies, normalization

Web based databases: XML documents and databases.

Reference:

1. R. Elmasri, S.B. Navathe, Fundamentals of Database Systems (5th Ed.), Pearson Education, 2010.
2. C. J. Date, A. Kannan and S. Swamynathan, Database Systems (8th Ed.), Pearson Education, 2003.
3. A. Silberschatz, H.F. Korth, S. Sudarshan, Database System Concepts (5th Ed.), McGraw Hill, 2010.
4. Philip J. Pratt. Joseph J. Adamski, Database Management Systems, Cengage Learning, First Indian Reprint 2009.

CSPL 606 – Database Management Systems Lab

Practicals based on CSPT 606 – Database Management Systems

CSCT 301 Linux System Administration

System Administration: Installation, Configuration, Disk Formatting/Partitioning, Installing Linux, Super user, Controlling Processes, User and group management, Backup management, Security management

System Maintenance : Linux Distributions, BIOS, Devices and drivers, System Monitoring, System Configuration, Applications Installation and Configuration, Maintenance (service packs, patches, etc.), Server services (database, web, network services.), Client services

Network System Maintenance: Network Configuration, Network services (File printing on Network, DHCP, DNS, FTP, HTTP, Mail, SNMP and Telnet)

Books:

1. E.Nemith, G. Snyder, T.R. Hein, Linux Administration Handbook, 2nd edition, Pearson Education, 2006.
2. Linux in a Nutshell, 6th Edition, Author : Ellen Siever, Stephen Figgins, 6th Edition O'Reilly, 2009.
3. Tony Batts, Gregor N. Purdy Terry Dawson Linux Network Administrator's Guide, 3rd Edition By, O'Reilly Media, 2005.
4. Nicholas Wells, the Complete Guide to Linux System Administration, Cengage Learning Indian Edition, 2005.
5. Documentation available at www.linux.org.

CSCL 301 Linux System Administration

Practicals based on CSCT 301 Linux System Administration

CSCT 402 (i) Multimedia Systems and Applications

Multimedia Input Devices : Scanner, digital camera, microphone, video camera type setter.

Multimedia Output Devices : Sound/speaker, colour monitors, printers, storage devices: CD Roms, DVD.

Coding and Compression Formats for Image, Audio, Video.

Nonlinear Form of Presentation : Hypertext, hypermedia, human/ computer interaction.

Cognitive Aspects of Information Transfer: Various models of structuring of content methodology for developing multimedia CDRoms.

Use of Multimedia tools: Sound editor, video editor, animator, authorising tools
Multimedia databases, multimedia applications in education, libraries publishing, art and culture, medicine and industry.

References :

1. Ze-Nian, Li Mark, F Drew, Fundamentals of Multimedia, Pearson Education–International Edition, 2005.
2. Tay Vaughan, Multimedia: Making it work, 7th Edition, Tata McGraw Hill, 2006.
3. Ranjan Parekh, Principles of Multimedia, Tata McGraw Hill, 2006.

CSCT 402(ii) Network and Information Security

Computer Networks and Topologies: Peer to Peer Networks, Server-Based Network, Bus, Star, Ring Topology, OSI Model Introduction.

TCP/IP and Internet: IPv4 Address Format, IPV6 Address Format, TCP, UDP, Use of IP address on Internet, DNS

Routing : Introduction to Routing, PING, CIDR, Trace Route, Ports and Sockets

Digital Crime: Computer Network as a Threat. Hardware vulnerability, Software Vulnerability, Criminology of Computer crime.

Risk Analysis and Threat: Risk Analysis Process, Understanding Computer Crime, Key principles of conventional computer security, Security Policies, Authentication, Data protection, Access control, Internal vs External Threat, security assurance, Computer Forensics and Incident Response

Information Gathering Techniques : Tools of the Attacker, Information and Cyber Warfare, Scanning and Spoofing, Password Cracking, Malicious Software, Session hijacking, Mail Vulnerabilities, Web Application Vulnerabilities, OS Vulnerabilities

Safety Tools and Issues: Cryptography, Firewalls, Logging and Intrusion Detection Systems, NT and Windows Security, UNIX/Linux Security, Ethics of Hacking and Cracking

Legal Standards: Policies, standards, procedures, and Cyber Law

Books :

1. Network Security, Terry Parode, Gordon Snyder, Cengage Learning, 2004.
2. Information Security Principles and practices by Mark Merkow and Jim Breithaupt, Pearson Education, 2005.
3. Computer Security concepts, Issues and Implementation by Alfred Basta, Wolf Halton, Cengage Learning India Edition, 2008.

CSCL 402 Software Lab

Practicals based on CSCT 402.

SEMESTER BASED SYLLABUS FOR PAPERS OTHER THAN MATHEMATICS / STATISTICS / OPERATIONAL RESEARCH / COMPUTER SCIENCE

Along with the above mentioned papers, a student will have to opt for four credit courses from disciplines other than Mathematics / Statistics / Operational Research / Computer Science and a qualifying paper. A student will have to choose one course each from Credit Course I in semester I , Credit Course II in semester II and Qualifying Course in Semester III .A student will have to opt for two courses from Credit Course III as Credit III.1 and Credit Course III.2 in semester IV and Semester VI respectively. In those subjects where more than one course is offered, the student shall opt for one of the course. **But if a student opts for Physics-II he/ she may opt for Physics(Lab).** The marks of Credit Course I, II, III.1 and III.2 shall count in the final result of the student.

Credit Course I

- (i) Ethics in Public Domain
- (ii) Environmental Issues in India
- (iii) Reading Gandhi
- (iv) The Individual and Society
- (v) Hindi Language, Literature and Culture
- (vi) Gender and Society
- (vii) Financial Management
- (viii) Chemistry
- (ix) Physics-I

Note: (a) Courses (i)-(vi) are the interdisciplinary courses of the BA (Hons) Programme.

(b) Course (vii) is the elective course EL 210 (vi) of B.Sc Programme.

(c) Course (viii) is the Paper V being taught in First year Physics (Hons).

(d) Course (ix) is the Paper V being taught in First year Chemistry (Hons).

Credit Course II

- (i) English
- (ii) Hindi
- (iii) Sanskrit
- (iv) Chemistry
- (v) Physics-I
- (vi) Chemistry (Lab)
- (vii) Physics (Lab)

Note: (a) Courses (i)-(iii) are the language credit courses of the BA (Hons) Programme.

(b) Course (iv) is the Paper V being taught in First year Physics (Hons). **For students of Maths (Hons), only six out of the twelve experiments will have to be done. These experiments may be selected at the college level.**

(c) Course (v) is the Paper V being taught in First year Chemistry (Hons).

- (d) Course (vi) is the Paper VIII being taught in First year Physics (Hons).
(e) Course (vii) is the Lab II being conducted in First year Chemistry (Hons).

Credit Course III

- (i) Psychology for Living
(ii) Hindi Literature
(iii) Modern Indian Literature, Poems and Short Stories; Novel or Play
OR
Cultural Diversity, Linguistic Plurality and Literary Traditions in India.
(iv) Formal Logic/ Symbolic Logic
OR
Readings in Western Philosophy
OR
Theory of Consciousness
(v) Citizenship in Globalizing World
(vi) Culture in India: a Historical Perspective
OR
Delhi: Ancient, Medieval and Modern
OR
Religion and Religiosity in India
OR
Inequality or Difference in India
(vii) Sociology of Contemporary India
(viii) Principles of Geography
OR
Geography of India
(ix) Principles of Economics
(x) Financial Accounting
(xi) Green Chemistry
(xii) Biotechnology
(xiii) Physics- II
(xiv) Biophysics
(xv) Physics (Lab)

Note: (a) Courses (i)-(ix) are the discipline centred courses of the BA (Hons) Programme.

(b) Course (x-xii) are the elective courses EL 210 (v), EL 310 (i) and EL 310 (iii) of B.Sc Programme.

(c) Course (xiii) is the Paper XI being taught in Second year Chemistry (Hons).

(d) Course (xiv) is the Paper XXII (Option 2) being taught in Third year Physics (Hons).

(e) Course (xv) is Lab V being conducted in Second year Chemistry (Hons)

MARKS:

* Each course carries 100 marks: examination 75 marks, internal assessments 25 marks.

* The pass mark is 40 percent.

NUMBER OF LECTURES:

* Four hours per week or Four classes for courses (i-xiv). For each of these courses, one tutorial will be held for students.

* Six hours or Six classes for course (xv).