Approved by Acad. Council on 07.09.2010

Ph.D. Course Work: Faculty of Science

(Session 2010 – 11)

Ordinances for "Course Work" for Ph.D. programme
Faculty of Science

Course work:

1. Every student admitted in a discipline for Ph.D. programme in the Faculty of Science will be required to pass a 'course work' of minimum 20 credits.

2. The candidate can submit his/her thesis only after passing the course work.

3. The 20 credit course will normally be spread over two semesters. **Semesters for Ph.D. courses will be in synchrony with PG semesters such that for those admitted in September/ March terms, the semester for course work will start with the next even/odd PG semesters, respectively.**

4. The 20 credits will be distributed as follows:

   (i)   Faculty level Compulsory Courses: -   3 credits

   Courses compulsory for all research scholars of Faculty of Science
   a. Ethics of Science   -   1 credit
   b. Science Communication   -   1 credit
   c. Research Methods & Good Lab practices   -   1 credit

   (ii)   Discipline – Specific Courses   -   7 credits

   These 7 credits may consist of Core and Elective courses as prescribed by the concerned discipline.

   (iii)   Research – Theme Specific courses   -   10 credits

   The courses for these 10 credits will be decided by the RPC of the concerned candidate out of the available courses offered by various departments.

5. Each discipline will announce the courses to be offered in a given semester prior to beginning of the semester and the research scholars will register themselves, in consultation with their RPC, for different courses.

6. Ph.D. scholars in one discipline may register themselves for courses offered by other disciplines if this is mutually permitted.

Examination and Evaluation:

Only end-semester examinations will be held for the Ph.D. courses offered in a given semester.

Normally examinations will be held two times in a year and will be notified by the Controller of Examinations. Every student will be required to fill up the examination form within the stipulated time notified by the Controller of Examinations. A candidate will be eligible for appearing in the examination, if he/she fulfills the minimum attendance requirement and submits the examination form within the stipulated time.

Attendance requirement will be the same as provided in Ph.D. ordinances.

A candidate, who does not fulfill the above requirements, will not be allowed to appear in the concerned examination.

There will be no evaluation/examination for the Faculty common courses: all research scholars will attend these courses and secure the minimal attendance requirement to qualify.

Preparation and presentation of seminar on research plan proposal and the other seminar, where applicable, and the review of literature, if applicable, will be evaluated by the concerned RPC while all Discipline-Specific and Research-Theme Specific courses will be evaluated by examiners appointed by the Board of Examiners.

Based on performance in the examination and other assessments, the candidate will be declared pass or fail. A candidate will be declared pass in a Discipline-Specific and Research-Theme Specific theory and practical course if he/ she secures at least 50% marks in the course. For other items viz., literature review/ field work etc., the candidate will be declared only passed or failed based on assessment by the concerned RPC without any marks being assigned. The preparation and presentation of research plan proposal, as required under the Ph. D. Ordinances, will be evaluated by RPC as well as DRC and the candidate declared pass or fail.

The candidate will be considered to have passed the course work of the Ph.D. programme only when he/ she has passed all the items of the Ph.D. course.

A candidate has to clear the course work in a maximum of the first four available semesters* of the residency period from the date of registration. A candidate can take a maximum of two attempts for passing a course/ item. If he/ she does not pass within this period, his/ her Ph.D. registration shall stand cancelled. There will be no provision of supplementary examination.

For those candidates who have been admitted in session 2009 – 10, this period will be applicable beginning from the session 2010-11.

Compulsory Courses for Faculty of Science

FSCP-01: Ethics in Science   Credit: 1

1. Science and ethics; science as the social, cultural and human pursuit.   1

2. Ethical theory and applications.   1

3. Interrelationships of science with technology and delivery.   1

4. The source of ethical issues in science: examples from different disciplines, e.g. biotechnology, medical sciences, defense research and development, environmental issues, space research, energy, food security etc.   3

5. Social and moral responsibilities of scientists and activists.   1

6. Ethical issues in science research and reporting: objectivity and integrity, the problem of plagiarism and related issues, international norms and standards.   2

7. Scientific temper and virtues; expectations from scientific community.   2

8. Desired temper of scientists: truthfulness, simplicity, humility, open mindedness; attitude of service towards social and human well being.   2

Suggested Readings:

1. David B. Resnik, 1998, The Ethics of Science: An Introduction. Routledge publisher, USA.
2. Callahan D. & Bok S., 1996, Ethics Teaching in Higher Education. Plenum Press, New York, USA.
3. Kapur J.N., 1996, Ethical Values for Ecellence in Education and Science, Wishwa Prakashan, New Delhi.
4. Tripathi A.N., 2008, Human Values. New Age International Publishers, New Delhi.

FSCP-02: Methods of Research and Good Laboratory Practices   Credit: 1

Methods of research:

1. **Hypothesis:** Literature Survey, defining the question and formulating hypothesis/ hypotheses   2
2. **Methods:** Collection of research data, tabulating and cataloging. Sampling and methods of data analysis   3
3. **Record keeping and analysis:** Generation of data, interpreting results/ data and drawing conclusions   2
4. **Laboratory Safety measures:** Handling of Radiation, Bio-hazardous and other toxic experimental materials   1
5. Facilitation of Scientific deliberations among students and faculty   1

Good laboratory practices:

1. Recording and storage/ retention of recorded materials   1
2. Maintenance of equipments, proper storage and disposal of hazardous materials (chemical & biological)   2
3. Management and user responsibilities in proper utilization of the facilities   1

Suggested Readings:

1. Jürg P. Seiler Good laboratory practice: the why and the how 2005. http://uqu.edu.sa/files2/tiny_mce/plugins/filemanager/files/4281709/good_laboratory_practice:_the_why_and_the_how.pdf
2. Good Laboratory Practice. http://en.wikipedia.org/wiki/Good_Laboratory_Practice
3. What is scientific method? http://www.experiment-resources.com/
4. Research methodology resources. http://edutechwiki.unige.ch/en/Research_methodology_resources
5. Overview of research methods. www.answer.com/ topic/ overview – of - research -methods

FSCP-03: Science Communication   Credit: 1

    1. Nature and importance of Communication in Science   2

    2. Preparation of manuscripts: review articles, research papers, books,
        monograms, research projects; review of manuscripts   5

    3. Survey of literature, and presentation of data   1

    4. Preparation of power point presentation   1

    5. Popularization of Science   2

    6. Socio – Legal issues: Originality, Integrity, IPR, Patents, Plagiarism   2

Suggested Readings:

1. A. Wilson: Handbook of Science Communication, 1998, Institute of Physics Publishing, Bristol, Philadelphia.
2. Science Communication: Theory & Practice; Stocklmayer, Gore MM, Bryant C (Eds.), 2002, Springer.
3. Laszis P: Communicating Science: A practical Guide, 2006, Springer.

Applied Microbiology, Botany & Environmental Science

(Department of Botany)

Preamble

The Ph.D. course work comprises common courses (3 credits), discipline-specific courses (7 credits) and research theme-specific courses (10 credits). Since our Ph.D. students come from different educational backgrounds, relevant courses will be chosen in consultation with the concerned RPC to compliment the previous education, improve specific skills required for thesis and subsequent career. The discipline-specific courses will have two theory and two laboratory courses. These courses will be compulsory for all the research scholars. The research theme-specific courses will have two theory papers of 3 credits each from given electives, two compulsory courses each of 2 credits for preparation and presentation of research plan proposal. A research scholar will select elective courses as suggested by the concerned RPC. Evaluation of the research plan proposal and presentation, and review of literature will be done by the concerned RPC.

OUTLINE

Discipline-Specific Courses   Credits: 7

Course Code	Title	Nature	Credits
BOPC-01	Instrumentation	Compulsory	2
BOPC-02	Techniques in Plant Sciences	Compulsory	3
BOPC-03	Lab. work based on BOPC-01	Compulsory	1
BOPC-04	Lab. work based on BOPC-02	Compulsory	1

Research Theme-Specific Courses   Credits: 10

Course Code	Title	Nature	Credits
BOPR-01 BOPR-02 BOPR-03 BOPR-04 *BIPR-01	**Any one of the following** (BOPR-01 to BOPR-04 and BIPR-01**:** Biofertilizer Technology Biodiversity and its Conservation Remote Sensing and GIS Cyanobacterial Biotechnology *Computational Approaches to Protein structure	Elective	3
BOPR-05 BOPR-06 BOPR-07 BOPR-08 BOPR-09 BOPR-10 BOPR-11 BOPR-12 BOPR-13 BOPR-14	**Any one of the following** (BOPR-06 to BOPR-15)**:** Air Pollution and Climate Change Photobiology and Molecular Biology of Cyanobacteria Plant Pathology and Plant Protection Plant Cell and Tissue Culture Conservation and Restoration Ecology Stress Biology and Molecular Genetics of Cyanobacteria Applied Phycology Environmental and Applied Microbiology Water Pollution Management Microbial Genetics and Biotechnology	Elective	3
BOPR-15	Preparation and presentation of research plan proposal	Compulsory	2
BOPR-16	Review of literature and presentation of a seminar on a research theme-related topic approved by concerned RPC	Compulsory	2

* The course will run at Mahila Mahavidyalaya, B.H.U.

COURSE CONTENTS

BOPC-01: Instrumentation Credits: 2

1. Microscopy: Principles and applications of phase contrast, differential image control, fluorescence, confocal, scanning and transmission electron microscopes.
2. Spectrophotometry: Principles and applications of UV-Visible, atomic absorption and fluorescence spectrophotometers, inductively coupled plasma emission spectrometer.
3. Chromatography: TLC, Gas chromatrograph, HPLC, FPLC.
4. Devices for collecting environmental samples.
5. Polarography: Oxygen electrode for photosynthetic measurement

Suggested Readings:
1. J.M. Miller, 2005, Chromatography - Concepts and Contrasts. John Wiley & Sons, New Jersey, USA.
2. R.L. Grab and E. F. Barry, 2004, Modern Practice of Gas Chromatography (fourth edition). John Wiley & Sons, New Jersey, USA.
3. W.J. Ough and I.W. Wainer, 1995, High Performance Liquid Chromatography-Fundamental Principles and Practices. Blackie Academic & Professional, Glasgow, Scotland.
4. B.D. Hames (ed.) 2002, Gel Electrophoresis of Protein- A Practical Approach. Oxford University Press Inc., New York, USA.
5. K. Wilson and J.Walker (ed.), 2010, Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press.
6. F.S. Parker, 1983, Applications of Infrared, Raman and Resonance Raman Spectroscopy in Biochemistry. Plenum Press, New York, USA.

BOPC-02: Techniques in Plant Sciences Credits: 3

1. Microbial culture techniques: Sterilization, culture media, types of cultures-batch and continuous, culture preservation.
2. Tissue culture techniques: Media preparation, sterilization, *in vitro* regeneration.
3. Sampling of soil, water and air; Vegetation sampling and analysis.
4. Field techiques for plant identification based on key characters.
5. Proteomics: Gel electrophoresis (native, SDS and 2-D), isoelectric focusing, MALDI-TOF, LC-MS, Gel documentation system.
6. Methods of chromosome study: Protocols for squash method, karyotype analysis, chromosome banding techniques.
7. Genomics: Isolation of genomic and plasmid DNA, PCR, blotting techniques, sequencing, EST, Microarray.
8. Measurement of radioisotopes and their applications in biological system.
9. Bioinformatics: Basic concepts and applications.
10. Biostatistics: Data analysis.

Suggested Readings:
1. J.B. Harborne, 1998, Phytochemical Methods- A Guide to Modern Techniques of Plant Analysis. Chapman & Hall, London, U.K.
2. S. Sadasivam and A. Manickam, 2005, Biochemical Methods. New Age International Private Ltd., New Delhi.
3. D. Heard (ed.) 2006, Analytical Techniques for Atmospheric Measurements. Blackwell Publishing Ltd., UK.
4. G.K. Agrawal, R. Rakwal, (Ed.) 2008, Plant Proteomics- Technologies, Strategies and Application. John Wiley & Sons, New York, USA.
5. M. Radojević and V.N. Bashkin, 1999, Practical Environmental Analysis. Royal Society of Chemistry, Cambridge, UK.
6. American Public Health Association (APHA), 1998, Standard Methods for the Examination of Water and Wastewater 19th edition. Washington, D.C.

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BOPC-03: Lab work based on BOPC-1   Credit: 1

BOPC-04: Lab work based on BOPC-2   Credit: 1

BOPR-01: Biofertilizer Technology   Credits: 3

1. Biofertilizers: Definition and types, importance of biofertlizers in agriculture.
2. Characteristics of biofertilizers: *Rhizobium, Azotobactor, Azospirillum*, Phosphate-solubilizing microorganisms, cyanobacteria, *Azolla,* Mycorrhizae.
3. Symbiosis: Physiology, biochemistry and molecular genetics of symbiosis.
4. Enzymes and their regulation: Nitrogenase, hydrogenase.
5. Production technology: Strain selection, sterilization, growth and fermentation, mass production of various biofertilizers.
6. Application technology: Standards and quality control, application for field and tree crops, nursery plants and seedlings.
7. Extension, promotion and marketing: Extension strategies, diagnosis for the effectiveness of inoculation, improvement in distribution system.

Suggested Readings:
1. J.R. Gallon and A.E. Chaplin, 1987, An Introduction to Nitrogen fixation, Cassel Educational Limited, London.
2. A.N. Rai, 1990, A Handbook of Symbiotic Cyanobacteria. CRC Press, Boca Raton, Florida, USA.
3. J.R. Postgate, 1987, Nitrogen Fixation, second edition. Arnold, London.
4. G. Stacey, R.H. Burris and H.J. Evans, 1992, Biological Nitrogen Fixation. Chapman & Hall.
5. J.I. Sprent and P. Sprent, 1990, Nitrogen Fixing Organisms: Pure and Applied Aspects. Chapman & Hall, London.
6. S. Kannaiyan, K. Kumar and K Govindrajan, 2007, Biofertlizers Technology. Saujanya Books, New Delhi.
7. N.S. Subbarao, 1997, Biofertlizers in Agriculture and Forestry. Indian Book House Limited, New Delhi.
8. P.A. Roger and Kulasooriya, 1980, Blue-green Algae and Rice. The International Rice Research Institute, Manila, Philipines.
9. G.S. Venkatraman, 1972, Algal Biofertlizers and Rice Cultivation. Today and Tomorrow Publications, New Delhi.

BOPR-02: Biodiversity and its Conservation   Credits: 3

1. Introduction to biodiversity.
2. Levels of biodiversity: Genetic, species, community and ecosystem.
3. Magnitude and distribution: Diversity gradients and related hypotheses, methods for biodiversity monitoring, megadiversity zones and hot spots.
4. Biodiversity and ecosystem functions: Concepts and models.
5. Biodiversity and ecosystem services: Provisioning, regulating, supporting and cultural.
6. Threats to biodiversity: Causes of biodiversity loss, species extinction, vulnerability of species to extinction, IUCN threat categories, Red data book.
7. Strategies for biodiversity conservation: Principles of biodiversity conservation, in-situ and ex-situ conservation strategies; Biodiversity act.

Suggested Readings:
1. V.H. Heywood, and R.T. Watson, 1995, Global Biodiversity Assessment, UNEP, Cambridge University Press.
2. D. Hill, M.Fasham, and P. Shaw, 2005, Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring. Cambridge University Press.
3. A.E. Magurran, 1988, Ecological Diversity and Its Measurement, Princeton University Press, Princeton, New Jersey.

4. J.S Singh, S.P Singh, S.R. Gupta, 2006, Ecology Environment and Resource Conservation, Anamaya Publishers, New Delhi.
5. Van Dyke, Fred, 2008, Conservation Biology: Foundations, Concepts, Applications, 2nd edition   McGraw Hill, New York, USA.
6. Peter J. Bryant, 2009, Biodiversity and Conservation, University of California, Irvine, USA.

BOPR-03: Remote Sensing and GIS   Credits: 3

1. Fundamentals of remote sensing; Principles of electromagnetic radiation and EM spectrum.
2. Sensors and platforms; Remote sensing satellites, multispectral, hyperspectral and thermal sensors; RS data acquisition systems.
3. Image processing; Image enhancement and visualization; Image interpretation and classification.
4. Microwave thermal remote sensing; Radar & laser altimetry.
5. Applications fo Remote Sensing; Integration of remote sensing and GIS.
6. Basic concepts of GIS; Cartographic principles, map projections and coordinate systems.
7. Geographic information and spatial data types; Hardware and software; Steps of spatial data handling; Database management systems: Spatial referencing.
8. Data quality, measures of location errors on maps.
9. Spatial data input, data preparation; Point data transformation.
10. Analytical GIS capabilities, retrieval and classification, overlay functions.
11. Neighborhood operations, network analysis, error propagation; Data visualization.

Suggested Readings:
1. P A. Burough and R. McDonnel, 1998, Principles of Geographical Information Systems, Oxford University Press.
2. J. B. Campbell, 1996, Introduction to Remote Sensing, 2nd Edition. Taylor and Francis.
3. A. P. Cracknell and L.W.B. Hayes, Introduction to Remote Sensing, Taylor and Francis, London.
4. P. Curran, Principles of Remote Sensing, Longman, London.
5. P. J. Gibson, Introduction to Remote Sensing, Taylor and Francis, London.
6. J. R. Jensen, 2000, Remote Sensing of the Environment: An Earth Resources Perspective, Prentice Hall, New Jersey .
7. G. Joseph, 2003, Fundamentals of Remote Sensing, University Press, Hyderabad.
8. T. M. Lillesand and R. W. Keifer, 2000, Remote Sensing and Image Interpretation, John Wiley and Sons, New York, 4th Edition, New York.
9. F. F. Sabins, 1986, Remote Sensing: Principles and Interpretation, W.H. Freeman & Co., 2nd Edition.

BOPR-04: Cyanobacterial Biotechnology   Credits: 3

1. Mass cultivation of cyanoabcteria under outdoor and indoor conditions.
2. Cyanobacteria as a source of fine chemicals, polysaccharides, bioactive molecules, pigments, antioxidants, lipids and polyunsaturated fatty acids.
3. Cyanobacteria as biofertilizer for paddy cultivation.
4. Hydrogen production by cyanobacteria: Mechanism, progress and prospects.

Suggested Readings:
1. Antonia Herrero and Enrique Flores (Eds.), 2008. The Cyanobacteria: Molecular Biology, Genomics and Evolution. Academic Press.
2. W. Klipp, B.Masepohl, J.R Gallon, W.E. Newton, 2004. Genetics and Regulation of Nitrogen Fixation in Free-Living Bacteria, Springer.

3. D.A. Bryant (Editor), 2004, The molecular Biology of Cyanobacteria, Kluwer Academic Publishers.
4. M. A. Borowitzka and L. J. Borowitzka (Eds). 1988 Microalgal Biotechnology Cambridge University Press, New York, USA.
5. B.A. Whitton and Malcolm Potts (eds.), 2000. The Ecology of Cyanobacteria. Their Diversity in Time and Space. Kluwer Academic Publishers.

BIPR-01: Computational Approaches to Protein Structure   Credits: 3

1. Properties of amino acids and peptide bonds.
2. Primary, Secondary, Tertiary and Quaternary Protein structure, Ramachandran Plot, Motif and domain.
3. Basics of Protein structure Determination.
4. Identification and predication of motifs and domain.
5. Protein Fold Classification.
6. Protein structure Prediction.
7. Principles of Protein - Protein interaction partner.
8. Principles of Protein small molecules interaction, Docking, Identification and design of inhibitors.
9. Engineering and design of Protein structure.

Suggested Readings:
1. A. Baxevanis and F.B.F Ouellett, (eds.), 1998. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John Wily and Sons, New York.
2. C. A. Orengo, D.T Jones and J.M. Thornton (eds.), 2008. Bioinformatics: Genes, Proteins and Computers, Taylor & Francic.
3. I. Eidhammer, I. Jonasses and W.R. Taylor, 2004. Protein Bioinformatics, J.Wiley.
4. Julie D. Thomson, 2008. Functional Proteomics, Humana Press.

BOPR-05: Air Pollution and Climate Change   Credits: 3

1. Atmospheric composition and climate; Gaseous and particulate pollutants, emission trends and scenarios; climate change, drivers of climate change, greenhouse gas emission scenarios; indoor air pollution.
2. Sulphur derivatives: Sources and cycling of sulphur, effects on plants, human health and ecosystems, mechanism of toxicity, resistance and buffering, sulphur metabolism, threshold and injury.
3. Nitrogen derivatives: Formation and sources; deposition, uptake, metabolism, critical load; effects on plants, human health and ecosystems.
4. Fluoride derivatives: Sources and cycling, bioaccumulation, threshold and injury; effects on plants, human health and ecosystems.
5. Oxidants: Formation and sources, photochemical smog; effects on plants and human health, mechanism of toxicity, resistance, critical load.
6. Stratospheric ozone depletion: Phenomenon, causes, irradiation scenarios; effects of enhanced UV-B on plants, microbes and human health, biological action spectra.
7. Greenhouse effects: Process; consequences, global warming, sea level rise, albedo, oceanic influences, agriculture, natural vegetation; effects of increased CO_2 on plants; human implications.
8. Acid rain: Formation, dispersion and deposition, trends; consequences on soil fertility, rivers and lakes; effects on plants, leaf injury, buffering, reproduction; forest decline; effects on fisheries.
9. Biomonitoring of air pollution: Concept, active and passive monitoring; bioindicator parameters; air pollution tolerance indices; control of air pollution by plants, green belt design.

Suggested Readings:
1. A.B. Pittock, 2009, Climate change, the Science, Impacts and Solution. (2nd edition). CSIRO publication.
2. Hirt Heribert, Kazuoshinozaki (Eds.), 2004, Plant Responses to Abiotic Stress. Springer-Verlag Berlin.
3. J.N.B. Bell and M. Treshow (Eds.), 2004. Air Pollution and Plant Life. John Wiley and Sons, England.
4. Jelte Rozema, Viannis Manetas, L. Bjorn (Eds.), 2001. Response of Plants to UV-B radiation; Kluwer Academic Publishers, the Netherland.
5. W.W Heck, O.C. Taylor and D.T Tingey (Eds.), 1988. Assessment of Crop Loss from Air Pollutants. Elsevier Applied Science, New York.

BOPR-06: Photobiology and Molecular Biology of Cyanobacteria   Credits: 3

1. Molecular aspects of cyanobacterial nitrogen fixation: Genetic structure of the N_2 fixation system, molecular mechanisms of heterocyst differentiation and metabolism, genetic aspects of nitrate, nitrite and ammonia assimilation.
2. Accessory light harvesting complex: Phycobilisomes, phycobiliproteins, linker polypeptides, energy transfer, gene organization, chromatic adaptation and gene expression.
3. Photobiology: Photobiological and molecular aspects of UV-induced damage and repair in cyanobacteria.
4. Molecular mechanisms of photoprotection: Mycosporine-like amino acids (MAAs), scytonemin.
5. Cyanobacterial toxins: Types of cyanobacterial toxin, molecular tools for the identification of toxic cyanobacteria, biochemical and molecular aspects of toxin production, ecological implications.
6. Basic strategies for the generation of transgenic cyanobacteria.

Suggested Readings:
1. Antonia Herrero and Enrique Flores (Eds.), 2008. The Cyanobacteria: Molecular Biology, Genomics and Evolution. Academic Press.
2. W. Klipp, B.Masepohl, J.R Gallon, W.E. Newton, 2004. Genetics and Regulation of Nitrogen Fixation in Free-Living Bacteria, Springer.
3. D.A. Bryant (Editor), 2004, The molecular Biology of Cyanobacteria, Kluwer Academic   Publishers.
4. Ingrid Chorus and Jamie Bartram, 1999. Toxic Cyanobacteria in Water: A guide to their public health consequences, monitoring and management. WHO.

BOPR-07: Plant Pathology and Plant Protection   Credits: 3

1. Historical and developmental aspects of plant pathology.
2. Mode of infection and role of enzymes and toxins in plant disease.
3. Defense mechanisms of plants against infection: Preexisting structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds.
4. Management of plant diseases: Cultural, chemical, biological, biopesticides, breeding for resistant varieties, plant quarantine,integrated pest management.
5. Post-harvest pathology: Fungal deterioration of food commodities, mycotoxins and health hazards, control measures.
6. Molecular plant pathology: Molecular aspects of host pathogen interactions - PR proteins, degradation of phytoalexins, systemic resistance mechanism; application of molecular biology to plant disease control - transgenic approach for crop protection, engineering chemicals that elicit defense response to plants.
7. Study of plant diseases caused by fungi, bacteria, viruses, nematodes and mycoplasma like organisms: Wart disease of potato, blight of colocasia, downy mildew of cucurbits, stem gall of coriander, peach leaf curl, ergot of bajra, smut

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of sugarcane, Karnal bunt of wheat, linseed rust, Tikka disease of groundnut, red rot of sugarcane, Panama disease (*Fusarium* wilt) of banana, bacterial blight of rice, leaf curl of tomato, yellow vein mosaic of bhindi, mosaic of sugarcane, potato spindle tuber mosaic, ear cockles of wheat, grassy shoot of sugarcane, phylloidy of sesamum, Citrus greening.

Suggested Readings:
1. G. N. Agrios, 1988, Plant Pathology, Academic Press.
2. John A Lucas, 1998, Plant Pathology and Plant Pathogens, Wiley-Blackwell CRC Press.
3. C. M. Dickinson, 2003, Molecular Plant Pathology, Bios Scientific Publisher
4. Robert N. Trigiano, M. T. Windham and A.S. Windham, 2003. Plant Pathology: Concepts and Laboratory Exercises, CRC Press.
5. P.D. Bridge and J.M. Clarkson, 1998, Molecular Variability of Fungal Pathogens, CAB International.
6. R. S. Singh, 2008, Plant Diseases, Oxford and IBH Publishing Co. Pvt Ltd.
7. R. S. Singh, 2008, Principles of Plant Pathology, Oxford and IBH Publishing Co. Pvt Ltd.
8. O.D. Dhingra and James B. Sinclair, 1995, Basic Plant Pathology Methods, CRC Press

BOPR-08: Plant Cell and Tissue Culture   Credits: 3

1. Historical perspectives.
2. Principles of plant tissue culture: Organization of laboratory, media composition and preparation, aseptic manipulation.
3. Cell culture and cell cloning.
4. Cellular totipotency: Process and mechanism.
5. Somatic embryogenesis: Induction and controlling factors.
6. Organogenesis: Process and controlling factors.
7. Haploids: Androgenic and gynogenic; obtention and promises.
8. Somatic hybridization: Isolation, culture and fusion of protoplasts: regeneration of hybrids and cybrids.
9. Clonal propagation: Micropropagation.
10. Somaclonal and gametoclonal variation and their selection.
11. Transgenic plants: Method of transformation, selection, identification, molecular analysis for confirmation and application.
12. Germplasm conservation and synthetic seed technology.
13. Industrial application: Suspension culture, hairy root culture and bioreactors.

Suggested Readings:
1. S.S. Bhojwani and M.K. Razdan, 2001, Plant Tissue Culture: Theory and Practice (Studies in Plant Science). Elsevier Science.
2. S.S. Bhojwani, 2005, Plant Tissue Culture, Vol 19: Applications and limitation Development in Crop Science. Elsevier Science.
3. Kane-Hermann Newmann, 2009, Plant Cell and Tissue Culture. A Tool in Biotechnology: Basics and Applications (Principles and Practice), Springer.
4. R.D. Hall, 1999, Plant Cell Culture Protocols (Methods in Molecular Biology). Humana Press.
5. Victor M Loyola- Vargas, Felipe Vanquey Flota, 2005, Plant Cell Culture Protocols (second edition). Humana Press.

BOPR-09: Conservation and Restoration Ecology   Credits: 3

1. Introduction to Conservation Ecology: Principles, postulates and ethics.
2. Population dynamics and conservation: Genetic variation and its loss, variation in natural populations, mechanisms of population regulation, habitat specific demography, population viability analysis.

3. Species and habitat conservation: Prioritizing species and habitat, protected area networks, theory of reserve design.
4. Diagnosis and prediction: Predicting ecological consequences of changes, environmental impact assessment.
5. Conservation strategies: Planning and management, plan process for species and site management; general principles of management; models of sustainable development.
6. Ecology of disturbed ecosystems: Ecosystem dynamics and stability, disturbances, impact of disturbances on the structure and functioning of ecosystems.
7. Aims and strategies of restoration: Concepts of restoration, ecosystem reconstruction, major tools used in restoration.
8. Restoration of biological diversity: Acceleration of ecological succession, reintroduction of biota.
9. Degradation and restoration of natural ecosystems: Forest, grassland and lake.
10. Restoration of degraded soils: Saline/sodic soils, contaminated soils, mine spoils.

Suggested Readings:
1. Mohan K. Wali (Editor), 1992, Ecosystem Rehabilitation, SPB Academic Publishing, The Hague, The Netherlands.
2. J. S. Singh (Ed.), 1993, Restoration of Degraded Land: Concepts and Strategies Rastogi Publications, Meerut.
3. Stuart L. Pimm, 1991, The Balance of Nature? Ecological Issues in the Conservation of Species and Communities, The University of Chicago Press, USA.
4. Robert L. Smith, 2001, Ecology and Field Biology, Benjamin Cummings.
5. B. Richard, 2010, Essentials of Conservation Biology, Fifth Edition, Primack Sinauer Associates Inc., U.S.A.
6. Graeme Caughley and Anne Gunn, 1996. Conservation Biology in Theory and Practice Publisher: Wiley Blackwell.
7. Martha J. Groom, Gary K. Meffe, C. Ronald Carroll, 2006. Principles of Conservation Biology, Third Edition, Sinauer Associates Inc., U.S.A.

BOPR-10: Stress Biology and Molecular Genetics of Cyanobacteria   Credits: 3

1. Stress environment: Abiotic factors (Water, temperature, light, pH, salinity and nutrient concentration); Stress habitats (physico-chemical characterization, species diversity and population dynamics).
2. Stress damages: Cell structure, proteins, nucleic acids, lipids and membranes, physiological process, protein synthesis.
3. Mechanism of adaptations: Role of carbohydrates, proteins, nucleic acids and lipids, pigment-involvements, signal transduction.
4. Genome organization of model cyanobacteria *Synechocystis* sp. PCC 6803, *Anabaena* sp. PCC 7120, plasmids, use of bioinformatics in nucleic acid sequence database, brief knowledge of sequence alignment and its significance.
5. Mode of gene transfer in cyanobacteria with special reference to conjugation, transformation, electroporation, spontaneous and induced mutagenesis, transposon mutagenesis, expression of foreign gene(s) in cyanobacteria and its consequences.
6. Cyanobacteria in human welfare: Production of fine chemicals, polysaccharides, bioactive molecules, pigments, antioxidants, lipids and polyunsaturated fatty acids, biofertilizer and hydrogen.

Suggested Readings:
1. D.A. Bryant, 1994. The Molecular Biology of Cyanobacteria , Kluwer Academic Publishers.
2. B.A. Whitton and Malcolm Potts (eds.), 2000. The Ecology of Cyanobacteria. Their Diversity in Time and Space. Kluwer Academic Publishers.

BOPR-11: Applied Phycology   Credits: 3

1. Models (Monod and Droop) of nutrient-regulated phytoplankton growth; common methods for mass cultivation of microalgae.
2. Causal factors and dynamics of freshwater and marine algal blooms; physical and chemical means and bio-manipulation (top-down and bottom-up) for controlling nuisance blooms.
3. Consequences of blooms including toxins of cyanobacteria and dinoflagellates; algal biofouling of ships and its control.
4. Commercial potential of *Spirulina, Dunaliella* and *Porphyra*; hydrogen production by algae.
5. High-rate algal ponds for the treatment of wastewaters and for the production of useful biomass and energy; immobilized and inactivated algal biomass for metal and nutrient removal.
6. A brief account of cyanobacterial genomics and proteomics .
7. Paddy field cyanobacteria: Qualitative and quantitative assessment of their biodiversity using molecular tools; their use as biofertilizer, reclamation of usar lands.
8. Influence of salt, heavy metals and acid rain on algae: Physiological and biochemical effects; biochemical and molecular mechanisms of tolerance.
9. Bioassays and field assessment of pollutant effects; single and multispecies laboratory bioassays; taxonomic and non-taxonomic approaches for the assessment of pollutant effects in nature.

Suggested Readings:
1. N.G. Car and B.A. Whitton (eds.), 1982, The Biology of Cyanobacteria. Blackwell.
2. L.C. Rai, J.P. Gaur and C J Soeder (Eds.), 1994, Algae and Water Pollution Schweizerbart'sche Stuttgart, Germany.
3. M. A. Borowitzka and L. J. Borowitzka (Eds). 1988, Microalgal Biotechnology Cambridge University Press, New York, USA
4. L.E. Shubert, (ed.) 1984, Algae and Ecological Indicators Academic Press.
5. L.C. Rai and J.P. Gaur (eds.), 2001, Algal Adaptation to Environmental Stresses: Physiological, Biochemical and Molecular Approaches, Spriger.
6. G.E. Fogg and B.Thake, 1987, Algal culture and Phytoplankton Ecology, Univ. Wisconsin Press.
7. R.N. Singh, 1961, Role of Blue-green Algae in Nitrogen Economy of Indian Agriculture.. I.C.A.R. Monograph on Algae, New Delhi.
8. J. Seckbach, (eds.). 2007, Algae and Cyanobacteria in Extreme Environment. Springer.
9. S.N. Bagchi, D. Kleiner, P. Mohanty (eds.), 2010, Protocols on Algal and Cyanobacterial Research. Narosa.
10. Chen Feng, Y. Jiang, (eds.). 2001, Algae and their Biotechnological Potential. Kluwer.

BOPR-12: Environmental and Applied Microbiology   Credits: 3

1. Microbes as tools for understanding the biological processes: Physiology, biochemistry, genetics, molecular biology, genomics, proteomics.
2. Microbes and environment: Pollution abatement, bioindicators, restoration of degraded ecosystems, biodegradation, bioremediation, biogenic gases, microbes in biological warfare.
3. Application of microbes in fermentation processes: Types, design and maintenance of bioreactors, application of fermentation technology in industry.
4. Medical microbiology: Microbes as causal agents of human and animal diseases; immunology: basic concepts, vaccines, immunotherapy.
5. Role of microbes in relation to agriculture: Nitrogen economy, plant health, biological control.
6. Symbiotic associations: Concepts, types and applications.

7. Microbes in food and dairy industry: Mushrooms, fermented foods, microbial spoilage of food and dairy products, toxins.
8. Extremophiles and their biotechnological applications.
9. Microbial technology: Biosensors, biomolecules, enzymes.

Suggested Readings:
1. R. Mitchell and Gu, Ji-Dong (eds.), 2010, Environmental Microbiology (Second Edition). Wiley-Blackwell.
2. Wen-Tso Liu and J.K. Jansson (eds.), 2010, Environmental Molecular Microbiology. Caister Academic Press, Norfolk.
3. C.J. Hurst, R.L. Crawford, J. L. Garland, D.A. Lipson, A.L. Mills and L.D. Stetzenbach (eds.), 2007, Manual of Environmental Microbiology, 3rd Edition. American Society of Microbiology Press.
4. I. Pepper and C. Gerba, 2004, Environmental Microbiology: A Laboratory Manual. Academic Press, London.
5. P. A. Rochelle, 2010, Environmental Molecular Biology: Microbiology Protocols and Applications. Horizon Press/Routledge, New York.
6. R. Mitchell, 1993, Environmental Microbiology. John Wiley & Sons Inc.
7. S. Kannaiyan, 2009, A Text Book of Applied Microbiology, Vols. 1 to 2. Associated Publishing Company, New Delhi.
8. K. Messley, 2003, Microbiology Lab Manual. Benjamin-Cummins.
   K. R. Aneja, P. Jain, A. Raman, 2008, A Textbook of Basic and Applied Microbiology. New Age, New Delhi.

BOPR-13: Water Pollution Management   Credits: 3

1. Freshwater: Classification of water bodies; physico-chemical and biological properties of freshwater; water quality at euphotic and profundal zones; drinking, bathing and irrigational water quality standards.
2. Water pollution sources: Major sources of water pollution; Physico-chemical and biological properties of sewage; quality of industrial effluents produced from textile, dairy, leather, thermal power and chemical industries.
3. Effect on water quality: Changes in water quality due to discharge of city sewage; industrial effluents; effects on phytoplankton productivity; bio-indicators of water pollution.
4. Domestic wastewater treatment: Various stages of treatment of sewage with special reference to advanced wastewater treatments; biological treatment of wastewater.
5. Industrial wastewater treatment: Treatment of industrial effluents released from textile, dairy, leather, thermal power and chemical industries.
6. Disinfection of treated water: Ozonization of secondary treated wastewater; chemical and other methods for disinfection.
7. Water management strategies: Rain water harvesting, use of rain water, recharging of ground water; use of domestic waste water; recycling of waste water; recycling of industrial effluents after treatment.
8. Water pollution monitoring and management bodies: Important organizations involved in water pollution monitoring in India and role of NGOs in water pollution management.

Suggested Readings:
1. Stanley E. Manhan, 2007, Environmental Science and Technology, Lewis Publishers, New York.
2. Stanley E. Manhan, 2001, Fundamentals of Environmental Chemistry, Lewis Publishers, New York.
3. Stanley E. Manhan, 2005, Environmental Chemistry, Lewis Publishers, New York.
4. APHA, 1998, Standard methods for examination of water and waste water, American Public Health Assocation, 18th Edition, Washington, D.C.

BOPR-14: Microbial Genetics and Biotechnology   Credits: 3

1. Tools of microbial genetics: Bacteriophages (T_4, lambda, Mu), *Neurosopra crassa.*
2. Mutation: Spontaneous and induced mutation, mutagens and their effects on DNA structure and protein synthesis.
3. Genetic recombination: Homologous recombination, site specific recombination and transposition.
4. Regulation of genome activity: Signal transmission, changes in genome activity, regulation of genome activity during development.
5. Gene expression and regulation: Lactose and Tryptophan operon, Regulation of virulence genes in pathogenic bacteria, heat shock regulon, SOS regulon and Cps regulon.
6. Cell signalling: Communication between cell and environment with special reference to nutrients (N and P) and temperature.
7. Bacterial associations in plants: perception and signaling.
8. Microbial toxins: Types, biochemical and molecular basis of toxins production, mode of action.
9. Gene manipulation for production of novel commercial products: biopolymers and antibiotics.

Suggested Readings:
1. Larry Snyder and Wendy Champnees. 2007, Molecular Genetics of Bacteria, 3rd Edition, ASM Press. Washington DC.
2. Jermy W Dale and Simon F Park, 2004, Molecular Genetics of Bacteria, 4th Edition, John Wiley & Sons.
3. Joseph W Lengler, Gerhart Drews and Hans G. Schlegel, 1999, Biology of the ProkaryotesBlackwell Science.
4. Benjamin Lewine, 2009, Genes X. Jones and Bartlett Publishers.
5. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick, 2007, Molecular Biology of the Gene. Cold Spring.
6. Bernard R. Glick and Jack J. Pasternak, 2009. Molecular Biotechnology: Principles and Application of Recombinant DNA. ASM Press, Washington, D.C.
7. T.A. Brown, 2008, Genomes. Garland Science (Taylor & Francis Group), New York & London.
8. Lodish Harvey, Berk Arnold, Zipursky S. Lawrence, Matsudaira Paul, Baltimore David and James E. Darnell, 2008, Molecular Cell Biology, VI Edition.

BOPR-15: Preparation and presentation of research plan proposal   Credits: 2

BOPR-**16**: Review of literature and presentation of seminar on a research theme-related topic approved by concerned RPC   Credits: 2

*Shall be evaluated by concerned RPC

BIOCHEMISTRY

(Department of Biochemistry)

Preamble

The research scholars of Biochemistry Department have to undergo a Ph.D. course work of minimum 20 credits. The evaluation of the candidates will be as per the ordinances of "course work" for Ph.D. programs in the Faculty of Science. The course work comprises of three components, the **Faculty Level Common Course** (**3 Credits**), **Discipline Specific Courses** (**7 Credits**) and **Research Theme Specific Courses** (**10 Credits**). The Discipline Specific Course comprises of two compulsory theory papers (BIPC-01 & BIPC-02) while Research Theme Related Course consists of three electives (BIPC-01, BIPC-02, BIPC-03) of 3 credits each and three compulsory course (BIPC-04, BIPC-05 and BIPC--06). Research Scholar has to choose any one of the elective courses (3 credits) along with preparation of research plan proposal (2 credits), presentation and defense of research plan (2credits) to earn 10 credits from Research Theme Course. The details of discipline-specific and research theme-specific courses are given below:

OUTLINE

Course Code	Title	Nature	Credits
Discipline-Specific Courses			Credits 7
BIPC-01	Tools and Techniques in Biochemical Research	Compulsory	4
BIPC-02	Biomolecules in Metabolic Disorders	Compulsory	3
Research Theme-Specific Courses			Credits 10
BIPR-01	Human diseases and preventive measures	Elective	3
BIPR-02	Stress metabolism in plants	Elective	3
BIPR-03	Molecular Enzymology	Elective	3
BIPR-04	Standardization of techniques/methods relevant to specific research area	Compulsory	3
BIPR-05	Review of literature and presentation of a seminar on a research theme-related topic duly approved by concerned RPC	Compulsory	2
BIPR-06	Preparation and presentation of Research Plan Proposal	Compulsory	2

* A student will have to choose any one of the electives listed above.

COURSE CONTENTS

BIPC-01: Tools and Techniques in Biochemical Research   Credits: 4

1. Proteins: Fractionation of proteins, Differential centrifugation, Chromatographic techniques, Gel permeation, Ion-exchange, Affinity, HPLC, FPLC. Electrophoretic techniques: PAGE, SDS-PAGE, Capillary electrophoresis. Proteomics: Proteome, 2D electrophoresis, MALDI-TOF/TOF, LCMS, Protein databases, BLAST.
2. Nucleic acids: Isolation and identification of DNA and RNA, Preparation of cDNA, amplification and sequencing, Hybridization techniques, cloning and expression of genes, PCR, RT-PCR, Transcriptome, Genome, Gene silencing and knock outs, Microarray.

3. Enzymes: Methods of enzymatic analysis, katal and international enzyme units, immobilization techniques, Application of enzymes.
4. Immunobiology: Immune response, Antigen-antibody interactions, Blotting techniques, Immuno-fluorescence, FACS, ELISA and ELISPOT.

Suggested Readings:
1. D.L. Nelson, &, M.M Cox, 2007, Lehninger's Principles of Biochemistry, 5th Edition, MacMillan Worth.
2. Lodish et al., 2008, Molecular Cell Biology, 6th Edition, Freeman.
3. Donald, Voet and J.G Voet, 2004, Biochemistry, 4th Edition, John Wiley & Sons Inc., USA.
4. Lewin, Benjamin, 2008, Genes IX, Jones and Bartlett's Publishers Inc.
5. T. A. Brown, 2007 Genomes, 3rd Edition, Garland Science Publishing.
6. Sambrook & Russell, 2001, Molecular cloning-a Laboratory Manual, 3rd Edition, CSHL Press.
7. Dixon and Webb, 1979, Enzymes, 3rd Edition, Academic Press.
8. Alan Wisemen, Hand book of Enzyme Biotechnology, 2nd Edition, John Wiley & Sons, New York.
9. Kindt et al. 2007, Kuby's Immunology, 6th Edition, Freeman.
10. Ivan M. Roitt, and Peter J. Delves, 2003, Essential Immunology, Blackwell Publishers.
11. Lorette C. Javois, 1999, Immunocytochemical Methods and Protocols, 2nd Edition, Humana Press Inc, New Jersey.

BIPC-02: Biomolecules in Metabolic Disorders   Credits: 3

1. Clinical disorders and biomolecules: Enzymes, isoenzymes, neurohumors and role of receptors in health and disease, Signal transduction, Apoptosis, Necrosis, Immuno-diagnostics and immunoprotection.
2. Stress disorders in plants: Environmental stresses and their impact on plant growth and metabolism; Transgenics in relation to sustainable food production.

Suggested Readings:
1. Murray Robert K.; Granner, Daryl K.; Mayes, Peter A. Rodwell, Victor, 2003, 26th Edition, Harper's Illustrated Biochemistry, McGraw-Hill.

BIPR-01: Human Diseases and preventive measures   Credits: 3

1. Prevalence, Etiology, pathophysiology, diagnostic and preventive measures associated with cancer, diabetes, gastrointestinal disorders, neurological disorders, filariasis, Leishmaniasis, malaria.
2. Diseases and model organisms.

Suggested Readings:
1. Eric Nestler, Steven Hyman and Robert Malenka, 2008, Molecular Neuropharmacology: A Foundation for Clinical Neuroscience, Second Edition, McGraw-Hill Professional.

BIPR-02: Stress metabolism in plants   Credits: 3

1. Salinity, water stress, heat, metal toxicity and metabolite alterations in plants.
2. Oxidative stress. Redox homeostasis.
3. Methods of assessing stress and toxicity in plants.

Suggested Readings:
1. M. Pessarakli et al, 1999, Handbook of Plant and Crop Stress, 2nd Edition, Marcel Dekker, Inc., New York.

2. M. Pessarakli et al, 2002, Handbook of Plant and Crop Physiology, 2nd Edition, Marcel Dekker, Inc., New York

BIPR-03: Molecular Enzymology   Credits: 3

1. Enzymes and their physico-chemical characterizations.
2. Molecular mechanisms and regulatory properties of dehydrogenases and hydrolases.
3. Enzymes in industries and diagnostics.

Suggested Readings:
1. N. C. Price, 1998, Fundamentals of Enzymology, 2nd Edition, Academic Press.
2. P. D. Boyer, 1970, The Enzymes, 3rd Edition, Vol I & II, Academic Press.

Bioinformatics

(Mahila Mahavidyalaya)

Preamble

The Ph.D. students of Bioinformatics, Mahila Mahavidyalaya, B.H.U. will be required to study courses of a **minimum** of **20** credits. In addition to common courses of the Faculty of Science carrying 3 credits, each student need to take discipline-specific courses (7 credits) and research theme-specific courses of minimum 10 credits.

A. Common Courses   Credits: 03

These are faculty-level courses and will be taught in the Faculty of Science.

B. Discipline-specific courses   Credits: 07

The student must opt for two courses comprising of a minimum of **7 credits** from the discipline specific courses B1 and**/**or B2 as recommended by the RPC.

C. Research theme specific course   Credits: 10/ 11

The students will be required to opt two courses from **C1** and **C2** of which BIPR-01, BIPR-02 and BIPR-03 of **4 + 2 + 2 credits** will be **compulsory**. They may opt any one of the other courses from Department of Biochemistry, Molecular and Human Genetics or Statistics (refer **C2** of Table 1) of **3-credits**.

Course Code	Course Title	Credits
Discipline Specific Courses (7 Credits)		
B 1		
BIPC-01	Programming Languages: C and Perl/ Python	04
BIPC-02	Object oriented Programming Languages: Java and Software Applications	03
BIPC-03	Basic Biochemistry and Immunology	03
BIPC-04	Microbiology and Biotechnology	03
BIPC-05	Introduction to Systems Biology	04
B 2 *Any one of the following that is offered by other disciplines*		
CSM-303B	Soft Computing Techniques (Department of Computer Science)	03
MGPC-03	Fundamentals of Molecular Biology (Deptt. of Molecular and Human Genetics)	03
STPC-02	Advanced Statistical techniques (Department of Statistics)	04
Research Theme specific course (10 Credits) **C 1**		
BIPR-01	Computational Approaches to Protein Structure *	04
C 2 *Any one of the following that is offered by other disciplines*		
STPR-08	Statistical Computing with R (Department of Statistics)	04
BCPR-01	Human Diseases and Preventive Measures (Department. of Biochemistry)	03
MGPR-01	Techniques in Molecular Biology (Deptt. of Molecular and Human Genetics)	03
BIPR-02	Review of literature and seminar on a topic other than thesis topic	02
BIPR-03	Preparation and presentation of Research Plan Proposal	02

  * Compulsory Course.

BIPC-01: Programming Languages: C and Perl/Python   Credits: 4

Basics of Computer and operating systems
Introduction to programming languages and paradigms, Syntactic Structure, Semantics, Data representation, Data abstraction, Procedure activation, Structured Programming, Block structuring
Concepts of flowcharting and algorithm development
Introduction to programming language C, data type, operators and expressions in C, control and repetitive statements: IF-THEN-ELSE, SWITCH, WHILE, FOR, DO. Break and continue statements, Input and Output functions, Function and Program Structure in C, Parameter passing, Pointers, Arrays, Structures, C-Library
Implementation of basic data structures and sorting problem
Perl for Bioinformatics: Basic concepts and application in biological sequence analysis / Python for Bioinformatics: Basic concepts and application in biological sequence analysis.

Suggested Readings:
1. Sethi, R., 1996, Programming Languages, Addison-Wesley.
2. Appleby, D. and Vandkopple, J.J., 1991, Programming Languages, Tata McGraw-Hill.
3. Kernighan, B.W. and Ritchie, D.M., The C Programming Language, PH.
4. Hutchinson, R.C. and Just, R.B., Programming using the C Language, McGraw-Hill.
5. Gottfried, B.S., Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill.
6. Schildt, H., C Made Easy, Osborne McGraw-Hill.
7. Tisdall, J.D. 2001 Beginning Perl for Bioinformatics. O'Reilly & Associates.
8. Darnell Soft ware Engineering Approach through C, Addison Wesley.
9. Schwartz R.L., Phoenix T. and Brian D.Foy, 2008, Learning Perl, V edition, O'Reilly, USA.
10. Wall L., Schwartz R.L. and Christiansen T. 2003 Programming Perl, II edition, O'Reilly Associates, USA.
11. Lutz M. 2008 Learning Python, III edition, O'Reilly Associates, USA
12. Marteli A. 2003 Python in a nutshell, O'Reilly Associates, USA.
13. Marteli and Ascher D. Ed. 2002 Python Cookbook, O'Reilly Associates, USA.
14. Curtis J.D. 2004 Perl Programming for Bioinformatics and Biologists, Wiley Dreamtech.

BIPC-02: Object Oriented Programming Languages: Java And Software Applications   Credits: 3

Java
Basics concepts of Object Oriented Programming
An introduction to Java Programming, Data Types and Variables, Loops, Strings, Arrays, Using Methods, Classes, and Objects, Constructors, Function overloading, Inheritance, Packages, I/O in Java.
Applets Basics, Applet Life Cycles
AWT: Windows, Graphics and Text: AWT Classes, Window Fundamentals, Working With Frame Windows, Frame Window in an Applet, Exploring Text and Graphics, Controls, Layouts and Menus Distributed Computing, Java programming tools (Java Beans), Application in Bioinformatics.

Software Application
Mathematical software package: MATLAB/SCILAB/MAPLE
Statistical Software package: R/SPSS

Suggested Readings:
1. Laura Lemay and Rogers Cadenhead , Teach Yourself JAVA 2 in 21 days, 1999, Sams Division of Macmillan Computer Publishing.
2. Patrick Naughton and Herbertz Schildt, The Complete Reference JAVA 2 TMH.
3. Balaguruswamy E, Programming in JAVA 2, TMH.
4. Computing Concepts with Java 2 Essentials,by Horstmann, John Wiley.
5. Rambaugh James etal"Object Oriented Design and Modeling, 1997 PHI.
6. Russel J.P, JAVA Programming, 2001, Prentice Hall of India ,New Delhi.
7. Schildt.H, JAVA 2 : The Complete Reference,2002, Tata McGraw Hill.
8. Maindonald J. and Braun J. Data Analysis and Graphics using R.: using problem based approach. 2005, Cambridge University Press.

BIPC-03: Basic Biochemistry and Immunology   Credits: 3

Section A: Biochemistry
Principles of Physical Chemistry applied to biomolecules: Chemical forces, hydrophilic and hydrophobic forces, van der Waal's forces, electrostatic interaction, hydrogen bonding.
 Laws of Thermodynamics, reversible and irreversible process, polar molecules, molar refraction and polarization, Dipole moment, non-covalent bonding in protein structure.
Amino Acids, Peptides, Proteins - Primary, Secondary, Tertiary and Quaternary Structures, Protein conformations
Enzymes: Determination of V_{max} and K_m using Michaelis-Menten and Lineweaver-Burk plots, Mechanism of enzyme action (binding of substrate, lowering of activation energy), effect of factors on enzyme activity (temperature and pH), basic concept of allosteric enzymes and inhibition

Section B: Immunology
General properties of immune responses: Innate and Adaptive immunity,
Haematopoiesis ; Cell and tissue/organs of immune system, Humoral and Cell – mediated immunity; Clonal selection and expansion; Cytokines and their functions.
Antigen, Hapten, Adjuvant; Molecular structure of antibodies and their interaction with antigens; Complement system and its activation; Hybridoma technology.
Disorders of Immune System: Autoimmunity; Immunodeficiencies and Hypersensitivity.

Suggested Readings:
1. Murray et. al., 2003 Harper's Illustrated Biochemistry. Prentice Hall Int.
2. Nelson, D.L. & Cox, M.M., 2004 Lehninger's Principles of Biochemistry 4th Edition.
   Macmillan UK, Worth Publishers, USA.
3. Berg, J.M., Tymoczko, J.L., Stryer, L., 2002 Biochemistry 5th Edition. W.H. Freeman & Co.
   New York.
4. Zubay, Geoffrey L., 1998 Biochemistry 4th Edition. Wm C. Brown Publishers, USA.
5. Lodish, H., Berk, A., Matsudaira, P., Kaiser, C.A., Krieger, M., Scott, M.P., Zipurskey, S.L.,
   Darnell, J., 2004 Molecular Cell Biology 5th Edition, Freeman.
6. Voet, Donald & Voet, J.G.., 2004 Biochemistry 3rd Edition. John Wiley & Sons Inc., USA.
7. Roitt, Ivan M. and Delves Peter J., 2003 Essential Immunology. Blackwell.
8. Goldsby Richard A., Thomas J. Kindt, Barbara A. Osborne, Janis Kuby, 2003 Immunology. Freeman.
9. Benjamin et. al., 2000 Immunology – A Short Course. Wiley-Liss.
10. Barrett, 1988 Text Book of Immunology. Mosloy.
11. Abbas et. al., 2001 Cellular and Molecular Immunology. Saunders.

BIPC-04: Microbiology and Biotechnology   Credits: 3

Diversity of micro-organisms; General characteristics of Archaea, Eubacteria,
Modern approaches to bacterial taxonomy and classification.
Structure of a prokaryotic cell.
Growth kinetics in batch cultures.

General characteristics and structure of different kinds of viruses; Structure and
replication of bacteriophages (T_2, and λ) and retroviruses.
Organization of viral and bacterial genomes.
Genetic recombination in bacteria: Conjugation, Transformation and Transduction;
Construction of genetic maps in bacteria

Biotechnology

Tools & techniques in recombinant DNA technology: enzymes and cloning vectors;
Polymerase chain reaction (PCR), DNA finger printing, DNA sequencing, Molecular
markers, Hybridization techniques
Plant cell & tissue culture - General introduction, concept of cellular differentiation and
totipotency, Gene transfer in plants; Application of recombinant DNA technology in
crop improvement
Basic techniques of animal cell and tissue culture, cell lines, pleuripotent stem cell
lines, stem cell culture, Gene transfer in animal systems, Molecular basis of human
diseases and Gene therapy.

Suggested Readings:
1. Prescott, L.M., Harley, J.P. and Klein, D.A. Microbiology, 6th Ed. 2005, McGraw.
2. Madigan, M.T., Martinko, J.M. and Parker, J. Brocks, Biology of Micro-
   organism. 11th Ed. 2006, Prentice Hall.
3. Snyder, L and Champress, W. Molecular Genetics of Bacteria .2nd Ed. 2003.
   ASM, Washington.
4. J.G. Black. Microbiology Principles and Explorations. 5th Ed. 2002. John Wiley
   and Sons.
5. Stanier, R.Y., Ingrahm, J.L. Wheelis, M.L. and Painter, P.R. General
   Microbiology 5th Ed.1987, Macmillan.
6. Tortora, C.J., Funke, B.A. and Case, C.L. Mircrobiology An Introduction, 8th Ed.
   2004. Pearson Education.
7. Streips & Yasbin 2002 Modern Microbial Genetics. Wiley.
8. Turn & Trumpy 2004 Fundamental of Bacterial Genetics. Blackwell.
9. Vold et. al. 1991 Essentials of Medical Microbiology. Lippincott & Co.
10. Jackson, J.F. and Linskens 2003 Genetic Transformation of Plants. Springer.
11. Butler 2004 Animal Cell Culture and Technology.
12. Bhojwani,S.S.and Razdan, M.K 2004 Plant Tissue Culture Elsevier.

BIPC-05: Introduction to Systems Biology   Credits: 4

Basic Concepts of Systems Biology
Introduction to Modeling in Systems Biology and Biological Models: Prey-Predator
model, Michaelis-Menten Model.
Biological Networks: representation, network visualization, reconstruction and
structural analysis of Biological Networks – Metabolic Networks; Transcription
regulation networks.
Metabolome and Interactome (basic concepts), protein- protein Interaction Databases,
and protein-protein interaction networks.
Systems Biology databases
Software for systems biology: Introduction to Simulation software, Virtual Cell and
Systems Biology Markup Language
Challenges and perspectives of Systems Biology

Suggested Readings:
1. H Kitano (ed.). Foundations of Systems Biology. MIT Press: 2001.
2. Fall, E Marland, J Wagner and JJ Tyson (Editors). "Computational Cell Biology." Springer Verlag: 2002.
3. G Bock and JA Goode (eds).In Silico Simulation of Biological Processes, Novartis Foundation Symposium 247. John Wiley & Sons: 2002.
4. E Klipp, R Herwig, A Kowald, C Wierling, and H Lehrach. Systems Biology in Practice. Wiley-VCH: 2005.
5. A Kriete, R Eils. Computational Systems Biology., Elsevier - Academic Press: 2005.
6. K. Sneppen and G. Zocchi, (2005) Physics in Molecular Biology, Cambridge University Press.
7. D. Noble, The Music of Life. Biology Beyond the Genome Oxford University Press 2006.
8. Z. Szallasi, J. Stelling, and V.Periwal (eds.) System Modeling in Cellular Biology: From Concepts to Nuts and Bolts (Hardcover), MIT Press: 2006.
9. B Palsson, Systems Biology - Properties of Reconstructed Networks Cambridge University Press: 2006.
10. K Kaneko. Life: An Introduction to Complex Systems Biology. Springer: 2006.
11. U Alon. An Introduction to Systems Biology: Design Principles of Biological Circuits. CRC Press: 2006.

CSM-303 B: Soft Computing Techniques   Credits: 3

Introduction to Genetic Algorithm, Genetic Operators and Parameters, Genetic Algorithms in Problem Solving, Theoretical Foundations of Genetic Algorithms, Implementation Issues.

Neural Model and Network Architectures, Perceptron Learning, Supervised Hebbian Learning, Backpropagation, Associative Learning, Competitive Networks, Hopfield Network, Computing with Neural Nets and applications of Neural Network.

Introduction to Fuzzy Sets, Operations on Fuzzy sets, Fuzzy Relations, Fuzzy Measures, Applications of Fuzzy Set Theory to different branches of Science and Engineering.

Suggested Readings:
1. M. Mitchell, An Introduction to Genetic Algorithms, Prentice-Hall.
2. D. E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley.
3. Z. Michalewicz, Genetic Algorithms+ Data Structures = Evolution Programs, Springer-Verlag.
4. N.K. Sinha & M. M. Gupta(Eds), Soft Computing & Intelligent Systems: Theory & Applications, Academic Press, 2000.
5. M.T. Hagan, H. B. Demuth, And M. Beale, Neural Network Design, Thompson Learning, 1996.
6. C. Lau (Ed), Neural Networks, IEEE Press.
7. J. Freeman and D. Skapura, Neural Networks: Algorithms, Applications, and Programming Techniques, Addison-Wesley.
8. G. J. Klir and T. A. Folger, Fuzzy Sets, Uncertainty, and Information, PHI.
9. G. J. Klir, and B. Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice-Hall, 1995.
10. H. J. Zimmerman, Fuzzy Set Theory and Its Applications, Kluwer Academic Press.

MGPC-03: Fundamentals of Molecular Biology   Credits: 3

1	Nucleic acids	8
	1.1 Base composition, structure and conformation 1.2 Nucleic acid chemistry: Denaturation, hybrids, nonenzymatic transformation, methylation. 1.3 Nucleosome &higher level organization	
2	Eukaryotic genome	5
	2.1 C-value paradox 2.2 Repetitive DNA 2.3 General concept of a gene 2.4 Gene families 2.5 Non-coding genes	
3	Replication in bacterial and eukaryotic chromosomes	4
	3.1 DNA polymerases 3.2 Replicons, origin and termination 3.3 Replisome	
4	Transcription	6
	4.1 Prokaryotic RNA polymerase, sigma factors, initiation and termination 4.2 Eukaryotic RNA polymerases and their promoters 4.3 Processing of transcripts	
5	Translation	3
	5.1 Genetic code 5.2 General mechanism of translation	
6	Regulation of gene expression	12
	6.1 Regulation of transcription initiation	
	6.1.1 Operon and regulon 6.1.2 Positive and negative regulation 6.1.3 Enhancers and promoters 6.1.4 Transcription factors: types, DNA binding motifs	
	6.2 Post transcriptional regulation	
	6.2.1 Alternative splicing 6.2.2 Transport and targeting of RNA 6.2.3 Post-transcriptional gene silencing	
	6.3 Translational control and targeting of proteins	
7	Mutation	1

Suggested Readings:
1   Alberts et al (1999). The Science of Genetics. Saunders
2   Benjamin (2003). Genetics: A Conceptual Approach. Freeman
3   Berg and Singer (1998). Genes and Genome.
4   Black (2002). Microbiology: Principles and Explorations. Wiley
5   Dale & Schartz (2003). From genes to Genome. Wiley & Sons
6   Griffiths et al (2002). Modern Genetic Analysis. Freeman
7   Griffiths et al (2004). An Introduction to Genetic Analysis. Freeman
8   Hartl et al (2002). Essential Genetics. Wiley & Sons

9   Klug & Cummings (2003). Essentials of Genetics. Prentice Hall
10   Latchman (1995). Gene Regulation. Chapman & Hall
11   Lewin (2007). Genes IX. Pearson
12   Maloy and Freifelder (1994). Microbial Genetics. Jones and Barlett
13   Meesfeld (1999). Applied Molecular Genetics. Wiley-Liss
14   Ptashne (1986). Genetic Switch. Blackwell
15   Russell (2002). Genetics. Benjamin
16   Streips & Yasbin (2002). Modern Microbial Genetics. Wiley
17   Trun & Trempy (2004). Fundamentals of Bacterial Genetics. Blackwell
18   Watson et al. (2004). Molecular Biology of the Gene. Pearson

STPC-02: Advanced Topics In Statistics   Credits: 4

ELEMENTS OF STOCHASTIC PROCESS
Poisson distribution and Poisson process, Inter-arrival time distribution in Poisson process, Constant hazard rate and exponential distribution, Time dependent Poisson process, Birth Process, Death Process, Birth – death process, Birth – death-immigration process, Random walk models, Gambler's run problem.

TOPIC ON RESEARCH METHODOLOGY
Definition and type of research, Steps in research process: Conceptual phase, empirical phase, analytical phase, Measurement, Report writing.

TOPIC ON MULTIVARIATE ANALYSIS
Factor analysis: Linear factor models, Estimation of factor loading, Factor rotation, Estimation of factors scroes, Testing goodness of fit, Cluster analysis.

STASTICAL COMPUTING
Use of computer and standard software like SPSS, SAS, STATA, SYSTAT, Writing FORTRAN/ C programmes for solving the problems related to the topic of CORE papers- II and II

Suggested Readings:
1. Medhi, J., 1982, Stochastic Processes, Wiley Eastern.
2. Parzen, E., 1962, Stochastic Processes, Holden – Day.
3. Hoel, P.G. Port, S.C. and Stone, C.J., 1972, Introduction of Stochastic Processes,, Houghton Miffin & Co.
4. Cinlar, E., 1975, Introduction of Stochastic Processes, Prentice Hall.
5. Ross, S. M., 1983, Stochastic Processes, Wiley.
6. Koyhari, C.R, 1985, Research Methodology: Methods and Techniques, Wiley Eastern.
7. Dominowski, R.L, 1980, Research Methods, Prentic Hall Inc., New Jersey.
8. Mishra, R.P, 1980, Research Methodology, Handbook Concept Publishing Company, New Delhi.
9. Rao, C.R, 1973, Linear Stastical Interface and Its Applications, Wiley Eastern.
10. Fruchter, B., 1967, Introduction of factor Analysis, D.Van Nostrand co.
11. Johnson, R and Wychern, 1992, Applied Multivariate Statistical analysis, Prentics Hall.
12. B.w. Kernighan and D.M. Richies, 1988, The c programming Language Second Edition,   Prentice Hall.
13. R.A. Thisted, 1988, Element of Statistical Computing, Chapman and Hall.

BIPR-01   COMPUTATIONAL APPROACHES TO PROTEIN STRUCTURE   Credits: 4

Properties of amino acids and peptide bonds.
Primary, secondary, tertiary and quaternary Protein structure, Ramachandran Plot; motif and domain.
Basics of protein structure determination.
Identification and predication of motifs and domain.

Protein fold Classification.
Protein structure prediction.
Principles of protein - protein interaction partner.
Principles of protein- small molecules interaction, docking, identification and design of inhibitors.
Engineering and design of protein structure.

Suggested Readings:
1. Baxevanis, A. and Ouellett, F.B.F (Editors) 1998 Bioinformatics: A Practical Guide to the analysis of Genes and Proteins. John Wily and Sons, New York.
2. Orengo C. A., Jones D.T and Thornton J.M.(Editors) 2008 Bioinformatics: Genes, Proteins and Computers, Taylor & Francic.
3. Eidhammer I., Jonasses I. and Taylor W.R. 2004 Protein Bioinformatics, J. Wiley.
4. Thomson Julie D. 2008, Functional Proteomics, Humana Press.

STPR-08: Statistical Computing with R   Credit: 4

R programming: Introduction and some preliminaries concept, simple manipulation with numbers and vectors, object their modes and attributes, array and matrices, reading data from files, conditional execution and looping, writing own functions, graphical producers .

Codes for generating distributions using R, examining distribution of a set of data, one and two sample tests, Statistical models in R: linear, generalized linear and non- linear models.

Practical assignments based on the above topics.

Suggested Readings:
1. Maindonald J. and Braun J. Data Analysis and Graphics using R.: using problem based approach. 2005, Cambridge University Press.

BCPR-01: Human Diseases and preventive measures   Credits: 3

1.   Prevalence, Etiology, pathophysiology, diagnostic and preventive measures associated with cancer, diabetes, gastrointestinal disorders, neurological disorders, filariasis, Leishmaniasis, malaria.
2.   Diseases and model organisms.

MGPR-01: Techniques in Molecular Biology   Credits: 3

1	Principles and applications of the following microscopy techniques	4
	1.1 Light Microscopy 1.2 Phase-contrast Microscopy 1.3 Fluorescence Microscopy 1.4 Confocal Microscopy	
2	Introduction to recombinant DNA technology	8
	2.1 Restriction and other enzymes used in recombinant DNA technology 2.2 Cloning vectors 2.3 Transformation	
3	Construction of genomic and cDNA libraries	2

4	Screening and characterization of clones	10
	4.1 Preparation of probes 4.2 Principles of hybridization based techniques: colony, Southern, Northern and in situ hybridizations 4.3 Western blotting, immunoprecipitation, ELISA 4.4 Expression based screening 4.5 Interaction based screening: yeast two-hybrid system	
5	Basic principles and applications of the following techniques	4
	5.1 DNA sequencing 5.2 Polymerase Chain Reaction 5.3 Microarray 5.4 Mass-spectrometry	
6	Promoter characterization	5
	6.1 Promoter analysis through reporter genes 6.2 Electrophoretic mobility shift assay 6.3 DNA foot-printin	
7	Mutagenesis	3
	7.1. Site directed mutagenesis 7.2. Transposon mutagenesis 7.3. Construction of knock-out mutants	
8	Gene transfer techniques	3
	8.1 Transfection of cells: Principles and methods 8.2 Germ line transformation in *Drosophila* and transgenic mice: Strategies and methods	

Suggested Readings:

1. Locquin and Langeron, 1983, Handbook of Microscopy. Butterwaths
2. Ausubel et al, 2002, Short Protocols in Molecular Biology. Wiley
3. Brown, 2000, Essential Molecular Biology VI. AP
4. Brown, 2000, Essential Molecular Biology VII. AP
5. Brown, 2006, Gene Cloning and DNA Analysis - An Introduction. Blackwell
6. Glick and Pasternak, 2003, Molecular Biotechnology. ASM Press
7. Kracher. Molecular Biology - A Practical Approach.
8. Krenzer and Massey, 2000, Recombinant DNA and Biotechnology. ASM
9. Micklos and Freyer, 1990, DNA Science. CSHL
10. Primrose, 2001, Molecular Biotechnology. Panima
11. Robertson et al, 1997, Manipulation & Expression of Recombinant DNA. AP
12. Sambrook et al, 2001, Molecular Cloning. CSHL
13. Twyman, 1999, Advanced Molecular Biology. Viva.
14. Watson et al, 1992, Recombinant DNA. Freeman.
15. Primrose and Twyman, 2006, Principles of Gene Manipulation and Genomics. Blackwell.

BIOTECHNOLOGY

(School of Biotechnology)

Preamble

In addition to faculty level courses of 3 credits, each student shall have to take up discipline-specific courses (7 credits) and research theme-specific courses (10 credits). The discipline-specific courses shall be compulsory for all the students. Research theme-specific courses shall comprise two papers (elective; carrying total eight credits) and a review/presentation project.

OUTLINE

Discipline-specific course (BTPC-01& BTPC-02)
Credits: 7

The discipline specific course work will constitute 2 courses of 3 credits and 4 credits. Details of courses are given in Annexure I and II.

Course Code	Course title	Credits
BTPC-01	Techniques in Biotechnology	**4**
BTPC-02	Applications of Biotechnology	**3**

Research theme-specific courses(A + B)   Credits: 10
(A). Elective: Any two of the following courses (4 credits + 4 credits = 8 credits) as per recommendations of RPC.

Course Code	Course title	Credits
BTPR-01	Immunology	4
BTPR-02	Animal Cell Culture	4
BTPR-03	Genetics and Molecular Biology	4
BTPR-04	Genetic Engineering	4
BTPR-05	Biochemistry and Biophysics	4
BTPR-06	Enzymology and Enzyme Technology	4
BTPR-07	Cell Biology	4
BTPR-08	Plant Biotechnology	4
BTPR-09	Microbiology	4

(B). Review/presentation project
BTPR-10: Review of literature and presentation of a seminar on a research theme-related topic approved by concerned RPC   Credits: 2

COURSE CONTENTS

BTPC-01: Techniques in Biotechnology   Credits: 4

1. **Techniques of Genomic Biology:** Introduction to recombinant DNA technology; PCR, Southern and Northern blotting, Microarray Technology, DNA foot printing; Electrophoretic Mobility Shift assays, transgenic technology, Targeted gene knock-out; Gene Silencing (anti-sense and Si RNA).
2. **Basics of Immunological techniques:** Techniques based on antigen-antibody interaction: Precipitation and agglutination reactions; ELISA, Immunofluorescence; Western blotting; Fluorescence Activated Cell Sorting; Immuno-histochemistry; Hybridoma technology and Monoclonal Antibodies.

3. **Animal cell culture:** Culture media; Introduction to basic techniques of establishing primary cultures and animal cell lines.
4. **Plant tissue and Organ Culture:** Culture media, establishment and maintenance of Cultures, Totipotency.
5. **Basic Techniques of Protein Chemistry:** Protein isolation and purification (including column chromatographies), Polyacrylamide Gel Electrophoresis (PAGE).
6. **Microbial biotechnology:** Isolation, purification, cultivation and preservation of microbes, identification based on molecular methods.
7. **Basic introduction to Bioinformatics**

Suggested Readings:
1. V S Mathura, 2009, Bioinformatics a Concepts Based Introduction. Springer Science, USA.
2. Neil & Jones, 2009, An Introduction to Bioinformatics. Ane Books, New Delhi
3. Mosier, 2009, Modern Biotechnology. John Wiley & Sons Inc. NY, USA.
4. Chirikjian, 2009, Biotechnology Theory & Techniques. CBS Publishers & Distributor, New Delhi.

BTPC-02: Applications of Biotechnology   Credits: 3

1. General applications of biotechnology in industry.
2. Free and immobilized enzymes and their role in industry.
3. DNA finger printing
4. Microbial Fermentation, Production of Primary/Secondary metabolites from microbes; Bioremediation
5. Application of Bioinformatics and computational biology
6. Role of biotechnology in agriculture and crop improvement.
7. Biofuels, Biofertilizers, Biopesticides and Biosensors.
8. Antigen-antibody reactions, Vaccines, Monoclonal antibodies, Immunotherapy
9. Animal cell culture technology; Cell culture products; Stem cells and Gene therapy.

Suggested Readings:
1. Hayes, 2010, DNA Biotechnology. Elsevier Science, USA.
2. N Gray, 2010, Enzymes Biotechnology Principles of Industrial Enzymes. CBS Publishers & Distributor, New Delhi.

BTPR-01: Immunology   Credits: 4

1. Introduction: Innate and acquired immunity, clonal nature of immune response.
2. Nature of antigens.
3. Antibody structure and function.
4. Antigen - antibody reactions and applications.
5. Major histocompatibility complex.
6. Complement system.
7. Hematopoiesis and differentiation.
8. Regulation of the immune response: Activation of B and T-lymphocytes, Cytokines, T-cell regulation, MHC restriction, Immunological tolerance.
9. Cell-mediated cytotoxicity : Mechanism of cytotoxic T cells and NK cells mediated target cell lysis, Antibody dependent cell mediated cytotoxicity, macrophages mediated cytotoxicity.
10. Hypersensitivity.
11. Autoimmunity.
12. Transplantation.
13. Immunity to infection and tumours.

Suggested Readings:
1. Hannigan, 2008, Immunology. Viva Books Pvt. Ltd., New Delhi.
2. Kuby, 1994, Immunology. WH Freeman and Company, NY, USA.
3. Roitt & Maled, 2007, Immunology. Mosby Edinburgh, NY, USA.
4. E. Benjamini Richard Coico,Geoffery, 2008, Immunology A Short Course. Sunshine A John Wiley & Sons. Canada.

BTPR-02: Animal Cell Culture   Credits: 4

1. Introduction to the balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium.
2. Biology and characterization of the cultured cells.
3. Measuring parameters of growth.
4. Basic techniques of mammalian cell cultures *in vitro*.
5. Serum & protein free defined media and their applications.
6. Measurement of viability and cytotoxicity.
7. Apoptosis
8. Cell synchronization
9. Cell transformation.
10. Applications of animal cell culture: cell culture based products, vaccines, Hybridoma technology and monoclonal antibodies, stem cells and their applications,.
11. Organ, organotypic and histotypic cultures.

Suggested Readings:
1. Freshney, 1994, Culture of Animal Cells. Wiley-Liss & Sons Inc. Publication USA.
2. Davis, 2004, Basic Cell Culture. Oxford University Press, INDIA.

BTPR-03: Genetics and Molecular Biology   Credits: 4

1. Introduction to cell division, Mendelian Laws and physical basis of inheritance, dominance and its molecular basis.
2. Basics of gene interaction, cis-trans-test and complementation test, lethal genes, polygenic traits, linkage and gene maps.
3. Double helix: Physico-chemical considerations.
4. Organization of prokaryotic and eukaryotic genomes, supercoiling, repetitive DNA.
5. DNA replication: Mechanism of replication of Prokaryotic & Eukaryotic Chromosome.
6. Mutation: Types and molecular mechanisms of mutations, mutagens, DNA Repair.
7. Transposition: Mechanisms of transposition, role of transposons in mutation.
8. Gene transfer in prokaryotes: Transformation, conjugation, transduction, construction of genetic maps in bacteria.
9. Recombination: Homologous and site - specific recombination.
10. Gene expression in bacteria: Transcription and its regulation; operons, attenuation, anti-termination and anti-sense controls.
11. Prokaryotic translation machinery, mechanism and regulation of translation.
12. Gene expression in eukaryotes: Transcription, general and specific transcription factors, regulatory elements and mechanism of regulation, processing of transcripts.

Suggested Readings:
1. Julio Lodge, 2007, Gene Cloning. Gardland Science Taylor & Francess Group USA & London

2. S Surzycki, 2000, Basic Techniques in Molecular Biology. Springer Science, USA.
3. Helen Kreuzer, 2008, Molecular Biology & Biotechnology: A Guide for Student. ASM Press Washington DC, USA.
4. Jun Ma, 2006, Gene Expression & Regulation. Springer Science, USA.
5. Cooper, 2007, The Cell : A Molecular Approach. ASM Press Washington DC, USA.
6. T.A.Brown, 2006, Genome 3. Gardland Science Taylor & Francess Group USA & London
7. Alberts/Watson, 2008, Molecular Biology of the cell. Garland Publishing, Inc. NY & London.
8. HD Kumar, 2010, Molecular & Synthetic Biology. Vitasta Pub., New Delhi.
9. Snustad, 2010, Principles of Genetics. John Wiley & Sons. Inc. NY, USA.

BTPR-04: Genetic Engineering   Credits: 4

1. Restriction Endonucleases, Modification Methylases and other enzymes needed in Genetic Engineering.
2. Cloning vectors: Plasmids and plasmid vectors, Phages and Phage Vectors, phagemids, cosmids, artificial chromosome vectors (YAC, BAC), CHEF analysis. Animal virus derived vectors - SV40 and retroviral vectors.
3. Molecular cloning: Recombinant DNA techniques, construction of genomic DNA and cDNA libraries, screening of recombinants.
4. Expression strategies for heterologous genes.
5. DNA analysis: labeling of DNA and RNA probes. Southern and fluorescence *in situ* hybridization, DNA fingerprinting, chromosome walking.
6. Techniques for gene expression: Northern and Western blotting, gel retardation technique, DNA footprinting, Primer extension, Sl mapping, Reporter assays.
7. Sequencing of DNA, chemical synthesis of oligonucleotides; techniques of *in vitro* mutagenesis. Site-directed mutagenesis, gene replacement and gene targeting.
8. Polymerase chain reaction and its applications.
9. Use of transposons in genetic analysis: Transposon and T-DNA tagging and its use in identification and isolation of genes.
10. Applications of genetic engineering: Transgenic animals, production of recombinant pharmaceuticals, gene therapy, disease diagnosis.
11. Biosafety regulation: Physical and Biological containment.

Suggested Readings:
1. Krebs Lewin's, 2010, Genes X. Jones & Barlett, London, USA
2. T A Brown, 2008, Gene Cloning & DNA Analysis. Black Well Publishing Inc., USA.
3. Hartl, 2009, Genetics Analysis of Genes and Genomes. Jones & Barlett, London, USA
4. Dale, 2007, From Genes to Genomes. John wiley & Sons Inc., NJ, USA
5. Snustad, 2010, Principles of Genetics. John wiley & Sons Inc., NJ, USA

BTPR-05: Biochemistry and Biophysics   Credits: 4

1. Carbohydrates; Glycolysis, Gluconeogenesis, Krebs' Cycle, Electron transport chain, Oxidative Phosphorylation.
2. Fatty acids; general properties and ß- oxidation.
3. Nitrogen metabolism: Amino acids (general properties); Amino acid sequencing and composition; end group analysis.
4. Proteins: Protein structure (primary, secondary, tertiary & quartenary), Globular, Fibrous proteins; Ramachandran plot, Circular Dichroism, Hydrophobic and hydrophilic interactions. PAGE, SDS-PAGE, Diagonal Electrophoresis, MALDI.
5. Protein folding (Introduction / Tools to study folding – unfolding phenomenon)

6. DNA - protein interactions; DNA-drug interactions.
7. Photosynthesis; carbon fixation and photorespiration

Suggested Readings:
1. Makee, 2009, Biochemistry. Oxford University Press, New Delhi.
2. Wilson & Walker, 2008, Principle and Techniques of Biochemistry & Molecular Biology. Cambridge University Press, USA.
3. Lehninger, 2008, Principles of Biochemistry. CBS Publishers & Distributors, Delhi INDIA.
4. Voet & Voet, 2008, Principles of Biochemistry. John Wiley & Sons Inc., NJ, USA
5. T.M. Devlin, 2006, Text Book of Biochemistry. John Wiley & Sons Inc., NJ, USA
6. M Cambell, 2007, Biochemistry. Thomson books/ Cole, USA & UK

BTPR-06: Enzymology and Enzyme Technology   Credits: 4

1. Classification and nomenclature of enzymes.
2. Isolation, purification and large-scale production of enzymes.
3. Coenzymes and Cofactors.
4. Steady state kinetics: Methods for estimation of rate of enzyme catalyzed reaction with special reference to Michaelis-Menten equation. Effects of substrate, temperature, pH and inhibitors on enzyme activity and stability.
5. Mechanism of enzyme action (active site, chemical modification) and regulation (Zymogens, Isozymes).
6. Enzyme engineering.
7. Applications of enzymes.
8. Immobilization of Enzymes.

Suggested Readings:
1. O Connor David, 2008, Proteomics. Scion Pub. Ltd., USA.
2. Price & Stevens, 2006, Fundamentals of Enzymology. W.H. Freeman & Company, NY, USA.

BTPR-07: Cell Biology   Credits: 4

1. Principles of Microscopy: Optical (including Phase contrast and Differential interference); Fluorescence, Confocal and Electron Microscopy.
2. Structure of Cell (Bacterial, Plant and Animal): Cell membranes, Composition & architecture of Cell Wall,
3. Structure and function of organelles (mitochondria, chloroplast, Nucleus, Golgi apparatus, Lysosomes, Ribosomes) and Cytoskeletal elements.
4. Cell adhesion; cell junctions, cell adhesion molecules & extra-cellular matrix.
5. Basic concepts of signal transduction.
6. Transport across biomembranes: facilitated transport, group translocation, Active transport, Na^+-K^+ ATPase pump.
7. Cell cycle and its control.
8. Oncogenesis.
9. Brief introduction to the biology of following pathogens: AIDS, Malaria, Tuberculosis and Kalajar.
10. Animal cloning and *in vitro* fertilization

Suggested Readings:
1. B. Lewin, 2007, Cells. Person & Prentice Hall, NJ, USA.
2. Thomas Pollard, 2002, Cell Biology. Saunders: Elsevier Science, USA.
3. Berk Lodish, 2008, Molecular cell Biology. W.H. Freeman & Company, NY, USA.
4. Gerald Karp, 2008, Cell & Molecular Biology. John Wiley & Sons. (Asia) Pte Ltd., NJ, USA
5. Cooper, 2007, The Cell a Molecular Approach. Saunders: Elsevier Science, USA.
6. Karp, 2010, Cell Biology. John Wiley & Sons. (Asia) Pte Ltd., NJ, USA

BTPR-08: Plant Biotechnology   Credits: 4

1. Tissue culture media, Initiation and maintenance of callus and suspension cultures; single cell clones.
2. Biochemical production.
3. Totipotency: Organoganesis; somatic embryogenesis; transfer and establishment of whole plants in soil (hardening).
4. Rapid clonal propagation and production of virus -free plants.
5. *In vitro* pollination; embryo culture and embryo rescue.
6. Protoplast fusion, selection of hybrid cells; symmetric and asymmetric hybrids, cybrids.
7. Nuclear cytology of cultured plant cells and somaclonal variations.
8. Production of haploid plants and their utilization.
9. Cryopreservation and slow growth for germ plasm conservation.
10. Gene transfer in nuclear genome and chloroplasts; *Agrobacterium*-mediated gene transfer, direct gene transfer, antibiotic marker-free transgenics.
11. Transgenic plants: insect resistance, virus resistance, abiotic stress tolerance, longer shelf life (including strategies for suppression of endogenous genes), male sterility, enhanced nutrition (golden rice), edible vaccines.
12. Molecular markers: RFLP, RAPD, AFLP, applications of molecular markers

Suggested Readings:
1. G Philips, 1996, Plant Cell Tissue & Organs culture. Narosa Pub. House, New Delhi.
2. Mangal, 2000, DNA markers in plant interaction. Gorland Press, UK
3. Iqbal Ahmed, 2008, Plant- Bacteria Interaction. Wiley & Sons Inc., NJ, USA.

BTPR-09: Microbiology   Credits: 4

1. History of Microbiology, Discovery of the microbial world.
2. Isolation, pure culture techniques, Methods of sterilization and Enrichment culture techniques.
3. Bacterial identification, nomenclature and classification, New approaches to bacterial taxonomy / classification including ribotyping and ribosomal RNA sequencing.
4. General structure and features all group of bacteria and cyanobacteria, Rickettsias, Chlamydias and Mycoplasmas,
   Archaea : Archaebacteria and extremophilic microbes – their biotechnological potentials
5. The definition of growth, growth curve, measurement of growth and growth yields, Culture collection and maintenance of cultures.
6. Different modes of nutrition in bacteria, Sulfate reduction, Nitrogen metabolism – nitrate reduction, nitrifying and denitrifying bacteria, Nitrogen fixation and Microbes used as biofertilizer.
7. Viruses : Classification, morphology and composition of viruses in general,
   Plant viruses (TMV, Gemini Virus), Animal viruses (baculoviruses),
   Bacteriophages: Lambda, ϕX 174, cyanophages,
8. Viroids and Prions.

Suggested Readings:
1. Peppler, 2008, Microbial Technology Vol I &I I. Academic Press, USA.
2. Mark Whalis, 2008, Principles of Modern Microbiology. John & Barlett, USA.
3. Black, 2008, Microbiology Principles & Applications. Black Well Publishing Inc. USA.
4. Jeffery, 2004, Fundamentals of Microbiology. Academic Press, USA.
5. Prescott, 2003, Microbiology. Mc Graw Hill. NY, USA.
6. Eldor A Paul, 2007, Soil Microbiology, Ecology & Biodiversity. Academic Press, USA.
7. S J Booth, 2010, Microbiology Pearls of Wisdom. John & Barlett, USA.

8. Pomerville, 2010, Alcamos Fundamentals of Microbiology. John & Banlett, USA.
9. Wheelir, 2009, Principles of Modern Microbiology. John & Barlett, USA.

Chemistry

(Department of Chemistry)

OUTLINE

A. Discipline-Specific courses   Credits: 7

Sl. No	Title of the paper	Paper Type	Credits
CHPC-01	Computational Chemistry	Compulsory	2
CHPC-02	Techniques for Structural Characterization and Materials Characterization	Compulsory	3
CHPC-03	Symmetry in Chemistry	Elective	2
CHPC-04	Advanced Separation Techniques	Elective	2
CHPC-05	Modern Electro chemical Techniques	Elective	2
CHPC-06	Emerging Methodologies and Reagents in Organic Synthesis	Elective	2

B. Research theme-specific courses   Credits: 10

Sl. No	Title of the paper	Paper Type	Credits
CHPR-01	Preparation and Presentation of Research Plan Proposal	Compulsory	2
CHPR-02	Review of Literature and presentation of Seminar	Compulsory	2
CHPR-03	Sensors	Elective	3
CHPR-04	Electrocatalysis & Alcohol Fuel Cells	Elective	3
CHPR-05	Solar Cells	Elective	3
CHPR-06	Nano Materials	Elective	3
CHPR-07	Polymer Chemistry	Elective	3
CHPR-08	Binary Crystalline Materials and their Optical and Electro-optic Properties	Elective	3
CHPR-09	Modern Organic Synthesis	Elective	3
CHPR-10	Medicinal Chemistry	Elective	3
CHPR-11	Bio-Inorganic Chemistry	Elective	3
CHPR-12	Supramolecular Chemistry	Elective	3
CHPR-13	Molecular Magnets and Liquid Crystals	Elective	3
CHPR-14	Organometallic Chemistry	Elective	3
CHPR-15	Density Functional Theory	Elective	3
CHPR-16	Biophysical Chemistry	Elective	3
CHPR-17	Phytochemicals	Elective	3
CHPR-18	Photochemistry	Elective	3

CHPC-01: Computational Chemistry   Credits: 2

1. **Introduction**: MS Office, Access, Excel, Origin, Chemdraw.

2. **Electronic structure calculations**: Introduction to Quantum Chemistry Packages-Gaussian, GAMMES etc.

3. **Definition and properties of Laplace transformations (LT):** Linear property, 1st and 2nd translation, LT of derivatives, integrals, and related multiplication and division properties. Solving special functions: Gamma, Bessel functions, unit impulse function, Dirac delta function; Inverse Laplace transformations; Convolution theorem.

Suggested Readings:
1. (a) Modern Quantum Chemistry: Introduction to Advance Electronic structure theory, Szabo and Ostlund, Macmillan, 1982.
   (b) Manual for Gaussian, GAMMES.
2. Schaum's Outline of Laplace Transforms, Murray Spiengel, McGraw-Hill, 1965.

CHPC-02: Techniques for Structural Characterization and Materials Characterization   Credits: 3

1. **Section – A: Techniques for Structural Characterization**

    Basic theory, instrumentation and analytical applications of the following physical methods: Spectroscopic techniques [NMR, ESR, MS (EI, FAB, MALDI-TOF), IR, UV-Vis, Fluorescence and Phosphorescence, Atomic Absorption], X-ray diffraction (single crystal XRD)

2. **Section – B: Techniques for Materials Characterization**

    Basic theory, instrumentation and analytical applications of the following physical methods: X-ray diffraction methods (powder method), Thermoanalytical methods (TGA, DSC, DTA), Microscopic methods (Polarized optical microscope, SEM, TEM, AFM), Surface Properties (XPS, BET), Mechanical Properties (DMA), Rheological properties (Viscometer, Rheometer), Electrical properties (Conductivity, Cyclic Voltammetry).

    Suggested Readings:
    1. R.M. Silverstein and F.X. Webster, 2003, Spectroscopic Identification of Organic Compounds, 6th Edition. John Wiley, New York.
    2. J.R.Dyer, 1978, Application of Absorption Spectroscopy of Organic Compounds. Prentice Hall, New Delhi.
    3. J.M. Hollas, 2004, Modern Spectroscopy, 4th Edition. John Wiley and Sons, Chichester.
    4. C.N. Banwell and E.M. Mc Cash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition., Tata McGraw Hill, New Delhi.
    5. R.S. Drago, 1992, Physical Methods in Chemistry, International Edition, Affiliated East-West Press, New Delhi.
    6. D.A. Skoog, F.J. Holler and T.A. Nieman, 1998, Principles of Instrumental Analysis, 5th Edition, Harcourt Brace & Company, Florida.
    7. H.A. Strobel, 1973, Chemical Instrumentation – A Systematic Approach, 2nd Edition, Addison Wesley, Mass.
    8. R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, 1976, Modern Methods of Chemical Analysis, 2nd Edition. John Wiley, New York.

CHPC-03: Symmetry in Chemistry   Credits: 2

1. General introduction, examples, relation to energy, correlation between symmetry and reactivity.

2. Symmetry elements and symmetry operations, general relation between symmetry elements and operations, the symmetry point groups, systematic procedure for symmetry classification of molecules.

3. The representation of groups, "The Great Orthogonality Theorem" and its consequences, Character tables.

4. Symmetry aspects of Molecular Orbital Theory, general principles, symmetry factoring of Secular Equations, carbocyclic systems, A more general case of LCAO-MO π-bonding (naphthalene as an example). Electronic excitation in naphthalene - selection rules.

5. Hybrid orbitals and molecular orbitals for AB_n type mlecules, transformation properties of atomic orbitals, hybridization schemes for σ and π orbitals, hybrid orbitals as linear combination of atomic orbitals, molecular orbitals for regular octahedral and tetrahedral molecules.

Suggested Readings:
1. F. A. Cotton, 1999, Chemical Applications of Group Theory, 3rd Edition. John Wiley & Sons, New York.
2. G. L. Miessler and D. A. Tarr, 1999, Inorganic Chemistry, 2nd Edition (1999), Prentice Hall International Inc., London.
3. K. Veera Reddy, 1999, Symmetry and Spectroscopy of Molecules, New Age International Pvt. Ltd., New Delhi.
4. R S Thakur 2007, Role of Symmetry Groups and Materials in Chemistry, Atlantic Publishers, New Delhi (2007).

CHPC-04 : Advanced Separation Techniques   Credits: 2

1. **Chromatographic techniques:** Introduction, classification of chromatographic methods, terms and relationships in chromatography, sample characterization.

2. **Principle, instrumentation and applications of :**
     (i) High performance thin layer chromatography(HPTLC)
     (ii) Gas chromatography (GC)
     (iii) High performance liquid chromatography (HPLC)
     (iv) Ion exchange chromatography(IEC)
     (v) Gel permeation chromatography(GPC/SEC)
     (vi) Affinity chromatography(AC)
     (vii) Supercritical fluid chromatography and extraction (SFC& SFCE)

3. **Hyphenated Techniques:** Principles and Applications of: LC-MS, GC-MS, GC-FTIR.

4. **Electrophoretic Separation Techniques:** Principle, Instrumentation and Applications of:
          i)   Polyacrylamide Gel Electrophoresis (PAGE)
          ii) Capillary electrophoresis (CE), High Performance Capillary Electrophoresis (HPCE)
          iii) Pulsed Field Gel Electrophoresis (PFGE)

5. **Membrane Separation Techniques:** Principle, Instrumentation and Application of :

i)   Reverse Osmosis (RO) and Nanofiltration (NF)
ii)   Ultra Filtration (UF)
iii)   Micro Filtration (MF)
iv)   Dialysis and Electro dialysis(ED)
v)   Pervaporation

Suggested Readings:
1. F.W Fifield & D.Keal, 2004, Principles and Practice of Analytical chemistry; Blackwell Publishing Company.
2. Pradyot Patnaik, 2004, Dean's Analytical Chemistry, Hand Book Second edition; McGraw- Hill Hand Books
3. J. D Seader /Ernest J. Henley, 1998, Separation Processes Principles;. John Wiley & Sons Inc. N.Y.
4. Skoog, Holler, Nieman, Principles of Instrumental Analysis Fifth edition; H.B College publishers.
5. G.H. and H. Freiser, 1958, Solvent Extraction in Analytical Chemistry, 1st Edition, John Wiley, New York.
6. B. L. Karger, L.R. Snyder and C. Howarth, 1973, An Introduction to Separation Science, 2nd Edition, John Wiley, New York.
7. E.W. Berg, 1963, Chemical Methods of Separation, 1st Edition, McGrw Hill New York.
8. D.G. Peters, J.M.Hayes and C.M. Hieftj, 1974, Chemical Separation and Measurements, 2nd Edition, Saunders Holt, London.

CHPC-05: Modern Electrochemical Techniques   Credits: 2

1. **Techniques based on Impedance measurements**: Application of impedance technique for studying electrode kinetics and corrosion, Measuring techniques, Representation of Faradic Impedance, Equivalent circuits, Kinetic parameters from impedance measurements, separation of R_S & C_S from total impedance, Use of the Fourier transformation in the analysis of data.

2. **Electrochemical Technique based on Rotating Disk Electrode:** Application of Rotating Disc Electrode (RDE) inthe measurement of electrochemical rate constant, Theoretical treatment of convective systems, Current – potential curves at RDE for reversible, irreversible and quasi-reversible reactions.

3. **Cyclic Voltammetry:** Methods based on voltammetry, current-potential relation applicable for Linear Sweep Voltammetry (LSV) and Cyclic Voltammetry (CV), Reversible, irreversible & quasi-reversible systems, interpretation of cyclic voltammograms and parameters obtainable from voltammograms.

4. **Other Techniques:** Basic principles related to Chronoamperometry, Chronocoulometry and Chronopotentiometry.

Suggested Readings:
1. J.O'M. Bockris and A.K.N. Reddy, 1998, Modern Electrochemistry, Vol. 1 & 2A and 2 B,, Plenum Press, New York.
2. A.J. Bard and L.R. Faulkner, 2001, Electrochemical Methods: Fundamentals and Applications; 2nd Edition, John Wiley & Sons, New York.

CHPC-06: Emerging Methodologies in Organic Synthesis   Credits: 2

1. **Emerging greener methodologies:** Sonochemistry and green aspects; Microwave in chemical synthesis: Basic principles, advantages and examples; Electrochemical synthesis: concepts and examples.

2. **Organic solvents:** Environmentally benign solvents, Solvent-free synthesis; Water as a reaction solvent; Ionic liquids

3. **Phase transfer catalysis:** Definition, Mechanism, Types of phase transfer catalysts, Synthesis and synthetic applications

4. **Transition metal catalyzed organic reactions**

5. **Organocatalysis**

Suggested Readings:
1. Mike Lancaster, 2002, Green Chemistry: An Introductory Text, Royal Society of Chemistry.
2. Nina Hall (Editor-in-chief), 2000, The New Chemistry, Cambridge university Press.
3. M.B. Smith & Jerry March, 2001, March's Advanced Organic Chemistry, 5th Edition, John Wiley & Sons, New York.
4. J. Clayden, N. Greeves, S. Warren and P. Wothers, 2001, Organic Chemistry, Oxford University press INC, New York.

CHPR-01 Preparation and Presentation of Research Plan Proposal   Credits: 2

CHPR–02 Review of literature and presentation of a seminar on a research theme-related topic approved by concerned RPC   Credits: 2

CHPR-03: Sensors   Credits: 3

1. **Chemical sensors I:** Types of chemical sensors based on the modes of transduction, Principles and construction of solid state potentiometric chemical sensors (ion-selective electrodes), Polymer-modified potentiometric chemical sensors and amperometric sensors. Some practical aspects of using chemical sensors.

2. **Chemical sensors II**: Principles and action with typical examples of optical sensors, Calorimetric sensors, Solid electrolyte and semiconductor gas sensors, and Mass sensors.

3. **Bio-sensors**: Theoretical and practical aspects of Clark and enzyme electrode, glucose bio-sensor, cholesterol bio-sensor, glucose bio-sensor based on NAD+/NADH, urea bio-sensor, and amino acid sensors.

4. **Molecularly Imprinted Polymer (MIP)-sensors**: MIPs in chemical analysis, MIP as biomimetic materials, MIP sensors vis-à-vis bio-sensors, Molecular imprinting strategies and procedures (non-covalent and covalent interactions), Methods for MIP synthesis, Important parameters in molecular recognition event, Role of porogen and cross-linkers, Polymer morphology and techniques of surface evaluation, Monolithic MIP films, MIP brushes, MIP beads, and MIP fibres, Development of MIP sensors and their integration with transducers, Limitations and advantages of MIP sensors, Recent trends and future.

Suggested Readings:
1. Robert W. Cattrall, 1997, Chemical Sensors, Oxford Chemistry Primers, Oxford Science Publications, 1997.
2. C.M.A. Brett and A.M.O. Brett, 1988, Electroanalysis, Oxford Chemistry Primers, Oxford Science Publications.

3. J. Janata, 1989, Principles of Chemical Sensors, Plenum Press, New York.
4. T. E. Edmonds (ed.), 1988, Chemoical Sensors, Chappman and Hall, New York
5. C. Alexander et al, **19**, 2006, 106, Journal of Molecular Recognition (a review article).

CHPR-04: Electrocatalysis & Alcohol Fuel Cells   Credits: 3

1. **A Review:** The Butler-Volmer (BV) current-potential equation for one electron transfer reaction under equilibrium and non-equilibrium conditions and physical significance of various terms involved in the equation. Discussion of the BV equation under low and high potential /over potential conditions. Tafel plot and its applications.

2. **The BV equation for multi-electron transfer reactions:** The rate dermining step, stoichiometrc number, transfer coefficient and electrochemical reaction order.

3. **Electrocatalysis**: Heterogeneous and electrocatalysis, relation between chemical and electrochemical rate (current density), advantages of electrocatalysis over heterogeneous catalysis, electrocatalytic scales, apparent and true current densities, electrochemical active surface area (EASA) and its determination (cyclic voltammetry, impedance and other methods).

4. **Mechanisms of some technologically important electrochemical reactions:** Hydrogen evolution reaction, oxygen reduction reaction, CO_2 reduction reaction and Cl_2 evolution reaction.

5. **Electrocatalysis for the direct alcohol fuel cells (DAFCs):** Introduction, thermodynamics and kinetics in a DAFC (DMFC: direct methanol fuel cell and DEFC: direct ethanol fuel cell), effect of catalyst structure and composition (methanol electrooxidation), Effects of foreign metals alloyed to Pt (comparison between ethanol and methanol).

Suggested Readings:
1. Marc T.M. Koper (ed), 2009, Fuel Cell Catalysis, Wiley Publication..
2. Eliezer Gileadi, 1993, Electrode Kinetics, VCH Publication.
3. Bockris & Reddy, Modern Electrochemistry.
4. S. Trasatti (ed.) 1981, Electrodes of Conductive Metallic Oxides (part A & B), Elsevier Publication (1981).

CHPR-05: Solar Cells   Credits:3

1. **Introduction to Solar Cells:** Basic Principles, Recent advances, Future prospects.

2. **Various types of Solar Cells:** p-n junction Photovoltaic cells, Photo-electrochemical cells.

3. **Application of solar cells:** Storage of solar energy, Thermal conversion, Photoconversion, Chemical production, Imaging & displays.

4. **Photoelectrochemical (PEC) cells:** General mechanism of Photo-electrochemical (PEC) cells, Classification of PEC cells, Regenerative Photo-electrochemical cells, Photo-galvanic cells and fuel producing cells.

5. **Dye-sensitized PEC Cells (DSSC):** Working principle of Dye-sensitized PEC Cells (DSSC), Use of sensitizers.

6. **Material aspects of Solar Cells:** Semiconductor materials, various forms of semiconductor materials, Preparation of semiconductor materials.

7. **Other aspects of Solar Cells:** Quantum efficiency, Stability, Strategies for higher efficiencies and key issues for the efficiency improvement, Economics of solar cells.

Suggested Readings:
1. A.J. Bard and L.R. Faulkner, 2001, Electrochemical Methods: Fundamentals and Applications;, 2nd Edition, John Wiley & Sons, New York.
2. G. J. Mayer, Chem. Soc. Rev. **38** (2009) 115.

CHPR-06: Nano Materials Credits: 3

1. Introduction, Size effect, Synthesis and assembly, techniques, General methods of preparation and synthesis.

2. Types of nano materials, their properties and applications. Nano- tubes, nano wires, nano rods, nano wire self-assembly. Carbon nano tube, single walled and multi-walled nano tubes. Bio nano materials.

3. Electro chemistry with nano particles, Nano sensors, biosensors, chemical sensors, electro catalysis.

4. Chemical method for the synthesis of gold and silver nano particles (spheres, nano rods and nano prism).

5. General applications and technology developments, futuristic applications and technologies. Nano bots, nanolabs, nano and beyond.

Suggested Readings:
    1. CNR Rao, Muller and Cheetham, 2005, The Chemistry of Nano Materials, Vol.I & II, Wiley-VCH.
    2. Geoffrey A. Ozin, and Andre Arsentte, 2005, Nano Chemistry, RSC Publishing.
    3. S.C. Tjong, 2006, Nano Crystalline Materials, Elsevier.
    4. Geozhog Gao, 2004, Nano Structures and Nano Materials, ICP.
    5. J.Storrs, 2006, Nano Fature, Hall, Manas Pulications, Delhi.

CHPR-07: Polymer Chemistry Credits: 3

1. **Introduction, Classification of Polymers, Intermolecular forces in Polymers.**

2. **Mechanism and kinetics of step-growth and chain growth polymerization:** Radical, cationic, anionic and condensation polymerization. Co-polymerization, Reactivity ratios, Thermodynamic aspects of polymerization. Mechanism of living radical polymerizations: Nitroxide mediated polymerization (NMP), Metal-catalyzed living radical polymerization, Reversible addition-fragmentation chain transfer (RAFT) Radical polymerization. Coordination polymerization, Ring opening polymerization, Types of polymerization process, Click chemistry.

3. **Polymer solutions:** Thermodynamics of polymer dissolution, The Flory-Huggins theory of polymer solutions, Nature of polymer macromolecules in solution, Size and shape of macromolecules in solution.

4. **Polymer structure and Physical properties:** Microstructure of polymer chains, crystallinity in polymers, thermal properties, rheological properties.

5. **Experimental methods:** polymer synthesis, isolation and purification of polymers, polymer fractionation, molecular weight determination, molecular weight distribution curve, determination of glass transition temperature.

6. **Speciality polymers:** Liquid crystalline polymer, Conducting polymers, Electroluminescent polymers, Inorganic polymer, Nanocomposites of polymer, Bio-polymer.

Suggested Readings:
1. F. W. Billmayer, Jr., 1984, *Text Book of Polymer Science*, 3rd Edition, Willey-Interscience, New York.
2. P. W. Atkins, *Physical Chemistry*, 6th Edition, Oxford University Press, New York.
3. G. Odian, 1991, *Principles of Polymerization*, 3rd Edition, John Wiley, Singapore
4. P. Bahadur and N.V. Sastry, 2002, Principle of Polymer Sciences, Narosa Publishing House, New Delhi (2002)
5. V.R. Gowarikar, N.V. Vishwanathan, J. Shreedhar, 1986, *Polymer Sciences*, Wiley Eastern, New Delhi.

CHPR-08: Binary Crystalline Materials and their Optical and Electro-optic Properties   Credits: 3

1. **Binary Materials:** Molecular association, Strong and weak interaction between molecules, different peculiar binary system and binary compounds, phase equilibria; binary eutectics- monotectics- peritectic- and molecular complexes system, solubility limits, microstructure.

2. **Synthesis and crystal growth of binary materials:** Solid state reactions and other different kind of reaction for synthesis of binary materials, Nucleation and crystallization, Experimental techniques for the growth of single crystal (Czochralski, Bridgman and Stock barger, Crystallization from solution), flux growth method, floating zone method, Merits and demerits of different methods.

3. **Optical, non-linear optical and electro-optic studies:** Linear and nonlinear optical properties, interaction of light with matter, concept of organic of electronic properties, Polar and molecular axis of molecule, harmonic generation, Merits and demerits of binary materials.

Suggested Readings:
1. Anthony R, 1998, Solid State Chemistry and its Application. West, John Wiley & Sons.
2. M.G. Kizyk and C.W. Dirk (Ed's) Characterization Techniques and Tabulations for Organic Nonlinear Optical Materials, Marcel Dekker, Inc. New York, 1998
3. W.D. Callister, 1997, Materials Science an Engineering-, 5th Ed, John Wiley & Sons

CHPR-09: Modern Organic Synthesis   Credits:3

1. **Formation of C-C bonds *via* organometallic reagents:** (i) Organo-lithium Reagents, (ii) Organo-magnesium Reagents, (iii) Organo-titanium Reagents, (iv) Organo-cerium Reagents, (v) Organo-copper Reagents, (vi) Organo-chromium Reagents, (vii) Organo-zinc Reagents, (viii) Organo-boron Reagents, (ix) Organo-silicon Reagents and (x) Palladium-Catalyzed coupling reactions.

2. **Aromatic C-C bond formation using Organo-boronic derivatives (The Suzuki reaction protocol):** (i) Homo-coupling of aryl boronic acids catalyzed by palladium (ii) Suzuki cross coupling of aryl boronic acids with aryl halides, (iii) Recent improvements in the Suzuki reaction for aryl-aryl bond formation and (iv) Use of new technologies in Suzuki cross coupling of aromatic substrates.

Suggested Readings:
1. George S. Zweifel, Michael H. Nantz, 2007; Modern Organic Synthesis - An Introduction, 1st Edition, ISBN: 978-0-716-77266-8; Ed. W. H. Freeman
2. Dale L. Boger, Modern Organic Synthesis, TSRI press.
3. P. S. Kalsi, 1996, Organic Reactions and Their Mechanisms, 1st Edition, New Age International Pub., New Delhi.
4. M. B. Smith, 1998, Organic Synthesis, Mc Graw Hill Inc, New York
5. J. Clayden, N. Greeves, S. Warren and P. Wothers, 2001, Organic Chemistry, Oxford University press INC, New York.
6. M.B. Smith & Jerry March, 2001, Marrch's Advanced Organic Chemistry, 5th Edition, John Wiley & Sons, New York.
7. Jie Jack Li, Chris Limberakis and Derek A. Pflum, 2007, Modern Organic Synthesis in the Laboratory, Oxford University Press

CHPR-10: Medicinal Chemistry   Credits:3

1. **General Aspects of Medicinal Chemistry:** Lead compound discovery strategies, structure activity relationship, role of functional groups in drug-receptor interactions, receptor mapping and molecular modeling.

2. **Receptors:** Drug receptor interactions, forces involved in the drug-receptor complexes, theories of drug-receptor interactions.

3. **Pro-drugs and drug delivery systems:** Types of pro-drugs, mechanism of drug activation, carrier linked pro-drugs.

4. **Drug metabolism:** Pathway for drug deactivation and elimination, oxidative reactions, reductive reactions, carboxylation reactions, hydrolytic reactions.

5. **A brief idea of the following:**
   (a) local anaesthetics: Butacaine sulfate, Euphthalmin, dibucaine hydrochloride
   (b) Sedatives and hypnotics: Cyclobarbitone, Glutethimide
   (c) Antipyratic and analgesic: Aminopyrine, mefenamic acid
   (d) Cardiovascular drugs: Bretylium tosylate, isoxsupurine hydrochloride
   (e) Antiparkinson agents: cycrimine hydrochloride, levodopa
   (f) Antimalarials: chloroquine, primaquine phosphate, pyrimethamine, artemisinine
   (g) Antibiotics: chloramphenicol, tetracycline *etc.*

Suggested Readings:
1. M.E. Wolff (Ed) 1995, Burger's Medicinal Chemistry and Drug Discovery Volume 1. Principles and Practice, 5Th Edition, John Wiley and sons. 1995.
2. C.G. Wermuth (Ed) 2003, The Practice of Medicinal Chemistry, 2nd Edition, Academic press, *An Imprint of Elsevier.*
3. Willian O. Foye, Thomas L. Lamke, David A. Wlliame, 1995, Principles of Medicinal Chemistry, 4th Edition.
4. Richard B. Silverman, 2004, The Organic Chemistry of Drug Design and Drug Action" 2nd Edition; Academic Press *An Imprint of Elsevier.*
5. Ashutosh Kar, 2004, Medicinal Chemistry, 4th Edition, New Age international Publishers.

CHPR-11: BIOINORGANIC CHEMISTRY   Credits: 3

1. **Biological significance of metal ions**: Fe, Zn, Cu, Mo, Co, Cr, V and Ni.

2. **Transition metal storage, transport and biomineralization**.

3. **DNA-metal interactions**: Intercalation and groove binding agents, metallo-drugs in cancer therapy: Pt(II), Ru(II) and Ru(III) complexes. Techniques of monitoring the interactions: Absorption, emission and NMR spectroscopy, Melting temperature method, Gel electrophoresis for DNA cleavage study.

4. **Metal containing electron transfer proteins**:
   (a) Iron- sulfur proteins – Rubredoxins, Ferredoxins and Rieske proteins
   (b) Blue copper protein
   (c) Cytochromes.

5. **Activation of O_2 and N_2 molecules**: Hemerythrin and Nitrogenases.

6. **Hydrogenases and Cyanocobalamines.**

Suggested Readings:
   1. M. N. Hughes, 1981, *Inorganic Chemistry of Biological Processes,* 2nd Ed, John-Wiley & Sons, New York.
   2. W. Kaim and B. Schwederski, 1995, Bioinorganic Chemistry: *Inorganic Elements in the Chemistry of Life, An introduction and Guide*, Wiley, New York
   3. S. J. Lippard and J. M. Berg, 1994, *Principles of Bioinorganic Chemistry*, University Science Books.
   4. I. Bertini, H. B. Grey, S. J. Lippard and J. S. Valentine, 1998, *Bioinorganic Chemistry*, Viva Books Pvt. Ltd., New Delhi.

CHPR-12: Supramolecular Chemistry   Credits: 3

1. **The chemistry of molecular recognition:** Host and Guest molecules. Molecular interactions in molecular recognition. Chiral recognition by crown ethers, supramolecular chemistry of coordination complexes, cyclodextrin- a naturally occurring cyclic host, calixarene- a versatile host.

2. **Controlling supramolecular topology-** the art of building supramolecules: Dendrimers- molecular trees, rotaxanes -threading molecular rings and catenanes -molecular capsules.

3. **Molecular self-assembly:** Programmed supramolecular assembly, structure and formation mechanism of cell membrane.

4. **Applications of supramolecules:** concept of a molecular device, reading signal from molecular devices, signal transduction, molecular electronic devices, molecular machines, biological super molecules, material transport- ion channels.

Suggested Readings:
   1. Ariga Katsuhiko, Kunitake Toyoki, 2006, Supramolecular chemistry-fundamentals and applications: advanced text book, Iwanami Shoten Publishers, Tokyo.
   2. Jean Marie Lehn, 1995, Supramolecular Chemistry: Concepts and perspective**,** Wiley-VCH..
   3. Crego-Calama, Mercedes Reinhoudt, Davis N. (Ed) 2006, Supramolecular chirality,. Topics in Current Chemistry, Vol 265, Springer Verlag
   4. Jonathan W. Steed and J. L. Atwood, 2000, Supramolecular Chemistry, 1st Edition, Wiley.
   5. Jonathan W. Steed, David R. Turner and Karl Wallace, 2007, Core concepts in Supramolecular Chemistry and Nano-chemistry, 1st Edition, Wiley.
   6. Paul D. Beer, Philip A. Gale and David K. Smith, 1999, Supramolecular Chemistry**,** , Oxford University Press, USA.
   7. Fritz Vögtle, 1993, Supramolecular Chemistry: An introduction, John Wiley.
   8. François Diederich, Peter Stang Rik R. Tykwinski, 2008, Modern

supramolecular chemistry: strategies for macrocycle synthesis,,Wiley-VCH.
9. L. F. Lindoy and I. M. Atkinson, 2001, Self assembly in supramolecular systems, Royal Society of Chemistry.

CHPR-13: Molecular Magnets and Liquid Crystals   Credits: 3

1. **Molecular Magnets**: Magnetization and magnetic susceptibility, Molecules containing a unique magnetic centre with and without first order orbital momentum, low spin-high spin transition, some selected examples, magnetic long-range ordering in molecular compounds: Design of molecular based magnets.

2. **Liquid Crystals**: Basic concepts, types of mesophases, design and synthesis of low molecular weight metallomesogens and matallomesogenic polymers, structural and mesophase characterization, Physical properties and applications of metallomesogens.

Suggested Readings:
  1. Oliver Kahn, Molecular Magnetism, VCH, Weinheim, Germany
  2. J.L.Serrano, Metallomesogens - VCH, Weinheim, Germany

CHPR-14: Organometallic Chemistry   Credits: 3

1. **Synthesis, structure and reactivities of:** Lithium alkyls, Grignard reagent, aluminium alkyls, alkylin compounds and organocuprates.

2. **Reaction meachanism of representative reactions involving:** i) Oxidative addition, ii) Reductive elimination, iii) Oxidative coupling, iv) Reductive extrusion, v) Insertion and vi) Elimination.

3. Preparation and properties of complexes containing η^n-hydrocarbon ligands.

4. Organometallic enzymes and coenzymes, role of organometallics in heavy metal poisoning, organometallic compounds and drugs, organometallics as radiopharmaceuticals and tracers.

Suggested Readings:
  1. F. A. Cotton and G. Wilkinson, 1999, Advanced Inorganic Chemistry, 6th Edn., John-Wiley & Sons, New York.
  2. James E. Huheey, 1993, Inorganic Chemistry, 4th Edn., Addison Wesley Pub. Co., New York.
  3. R.H. Crabtree, 1988, The Organometallic Chemistry of the Transition Metals, 1st Edn., John- Wiley & Sons, New York.
  4. J. P. Collman, L.S. Hegedus, J.R. Norton and Richard G. Finke, 1987, Principles and Applications of Organotransition Metal Chemistry, 1st Edtion, University Science Books, Mill Valley, California.
  5. Ch. Elschenbroich, A. Salzer, 1991, Organometallics: A Cosize Introduction, 2nd Edn. VCH.
  6. B D Gupta and AJ Elias 2010, Basic Organometallic Chemistry: Concepts, Syntheses and Applications, Universities Press, Hyderabad.
  7. Gerard Jaouen (Ed.), 2005, Bioorganometallics, Wiley-VCH.

CHPR-15: Density Functional Theory and Its Applications in Chemistry   Credits: 3

1. **Elementary Quantum Chemistry**: Schrödinger Equation, Variation principle, Hartree-Fock approximations.

2. **Electron Density**: Functionals, One electron density, Pair density, Kohn-Sham

orbitals, Basis sets.

3.   **Applications**: Molecular structure, Thermo-chemistry, UV-vis spectral analysis using TDDFT, Magnetic properties, Hydrogen bonds and weakly bound systems.

Suggested Readings:
  1. Wolfram Koch and Max C. Holthausen, 2000, A Chemist's Guide to Density Functional Theory", Wiley-VCH, NY.
  2.   Robert G. Parr and Weitao Yang, 1989, Density Functional Theory of Atoms and Molecules, Oxford University Press, Oxford.

CHPR-16: Biophysical Chemistry   Credits: 3

1.   **Introduction:** Concept of buffers, hydrogen ion titration curves, water balance, hydrogen bonding, ionic interactions and hydrophobic interactions.

2.   **Structure and function of biological membranes:** Ion transport through biological membranes, irreversible thermodynamic treatment of membrane transport, passive diffusion, mediated transport, active transport, Donnan membrane equilibria and membrane potential.

3.   **Enzymes - functions, kinetics and inhibition:** Chemical nature of enzymes, mechanism of enzyme action, kinetics of enzyme catalyzed reactions, enzyme inhibitory reactions, determination of Michaelis constant and inhibitory constant.

4.   **Thermodynamics and bio-energetics:** Thermodynamics of bio-polymer solutions, generation and storage of metabolic energy, free energy in biological system, free energy change and redox potential

Suggested Readings:
  1. Charles R. Cantor and Paul R. Schimmel, 2004, Biophysical chemistry: Part 1st 2nd & 3rd W.H. Freeman & Company, New York.
  2. Thomas M. Devlin, 2006, Text book of Biochemistry, with clinical correlation, 6th Edition, J.Wiley & Sons Inc.
  3. J. M. Berg, J. L. Tymoczko, Lubert Stryer, 2002, Biochemistry,, International edition, W.H. Freeman, New York.
  4. David L. Nelson & Michel. M. Cox, 2007, Lehninger, Principles of Biochemistry, 4th Edition, W.H. Freeman & Company, New York.
  5. Donald Voet, Judith G, Voet Charlotte W. Pratt, J., 2006, Fundamentals of Biochemistry, Wiley & Sons Inc.

CHPR - 17: Phytochemicals   Credits: 3

1.   **Definitions, introduction and occurrence.**

2.   **Modern techniques of isolation of the following classes of phytochemicals**: (i) Alkaloids, (ii) Anthocyanins, (iii) Carbohydrates, (iv) Carotenoids, (v) Steroids, (vi) Saponins, (vii) Terpenoids and (viii) Vitamins.

3.   **Structural elucidation of phytochemicals:** Introductory steps (chemical as well as physical) involved in their structural elucidation

4.   **Important chemical reagents and reactions from structural elucidation point of view.**

5.   **Biological and pharmacological properties of phytochemicals**: Introductory knowledge and steps to be taken for the study.

Suggested Readings:
1. I L Finar, 2009, Organic Chemistry vol.2 by, 5th Edition.
2. Thomson, Natural Products.
3. PD Mayo, Mono and sequiterpenoids.
4. Manske, The alkaloids.
5. Tetrahedron vol.47, 22, 1991
6. Maurice Shamma, 1972, The Isoquinoline Alkaloid, Academic press, Verlag Chemie.
7. Arnason, Mata, Romeo, 1995, Phytochemistry of Medicinal Plants, Volume 29, Plenum Press, New York.
8. Robert F. Raffauf, 1970, A Handbook of Alkaloids and Alkaloid-Containing Plants, Wiley-Interscience, New York, London.
9. B. Kumar, H. K. Chopra, 2005, Biogenesis of Natural Products, Alpha Science International Ltd.
10. Stephen P. Stanforth, 2006, Natural Product Chemistry at a Glance, Blackwell Publishing Ltd.,
11. J. B. Harborne, 1998, Phytochemical Methods, Third Edition, , Publisher: Chapmann & Hall, an imprint of Thomson Science.
12. Paul M. Dewick, 2002, Medicinal Natural Products: A Biosynthetic Approach, Second Edition, John Wiley & Sons Ltd.
13. Monika Waksmundzka-Hajnos, Joseph Sherma, Teresa Kowalska, 2008, Thin layer Chromatography in Phytochemistry, CRC Press, Taylor & Framcis Group, London, New York.
14. Thomas L. Lemke, David A. W. Williams, Vichria F. Roche, S. William Zito, Foye's Principles of Medicinal Chemistry, 6th ed., 2008, Lippincott Williams & Wilkins, a Wolters Kluwer business, Baltimore, USA

CHPR-18: Photochemistry   Credits: 3

1. **Principles of photochemistry:** Electronic excitation, State energy diagram, Singlet and Triplet states, Franck-Condon principle, Radiative lifetime, Quantum yields, Quenching Rates and mechanism, Excimers and Exciplexes, reaction of excited states such as energy transfer and electron transfer, Quenching and sensitization.

2. **Introductory idea about photochemistry and photophysics:** Transition metal and f-block complexes with special reference to $Ru(bpy)_3^{2+}$ and $Rh_2(bridge)_4^{2+}$ complexes (bridge = $NCCH_2CH_2CH_2CN$).

3. **Fluorescence anisotropy**: Definition, theory, measurement, effect of rotational diffusion on fluorescence;
   Time dependent anisotropy decays: Time domain anisotropy decay analysis, Anisotropy decay laws.

4. **Steady state measurement:** fluorimeter, fluorophores, intrinsic, extrinsic fluorophores, various probes: for DNA, fluorozonic, long life time and chemical sensing probes, solvent effect on emission spectra, FRET, use of FRET to measure macromolecular associations; DNA hybridization, fluorescence *in-situ* hybridization, fluorescence sensing.

5. **Photochemical synthesis** of novel organic compounds.

Suggested Readings:
1. D.M.Roundhill, 1994, Photochemistry and Photophysics of Metal Complexes, Plenum Press, NewYork and London, 1994.
2. O.Horvath and L.Stevenson, 1992, Charge Transfer Photochemistry of Coordination Compounds, VCH Publishers, NewYork.
3. Otto S. Wolfbeis, 1993, Fluorescence Spectroscopy: New Methods and

Application. 1993.
4. J.R.Lakowicz, 1999, Principles of Fluorescence Spectroscopy, 2nd edition, Kluwer
Academic Publishers / Plenum Press, NewYork, 1999.
5. Rohtagi Mukherjee, Fundamentals of Photochemistry.

COMPUTER SCIENCE

(Department of Computer Science)

Preamble

The Ph.D. Course Work in Computer Science shall be of two semester duration. The total credits shall be 20. There shall be three common compulsory courses of 1 credit each to be taught to all the research scholars registered under the Faculty of Science. There shall be two discipline-specific courses of 7 credits compulsory to all the research scholars, irrespective of their fields of research. There shall be fifteen research-theme related courses of 4 credits each, out of which a scholar will be required to opt any two. The research theme-specific course CSPR-16 (Computational Tools and Techniques) shall be compulsory for all the students.

The titles, contents of the papers and distribution of credits of discipline-specific and research theme-specific courses shall be as follows:

OUTLINE

Course Code	Course Title	Credits
Discipline-Specific Courses		Credits: 7
CSPC-01	High Performance Computing (Compulsory)	04
CSPC-02	Simulation: Theory and Practice (Compulsory)	03
** **Research Theme-Specific Courses**		Credits: 10
CSPR-01	Advanced Course in Algorithms	04
CSPR-02	Computational Intelligence	04
CSPR-03	Architecture and Design of Software Systems	04
CSPR-04	Data Warehousing and Mining	04
CSPR-05	Grid Computing	04
CSPR-06	Bioinformatics Computing	04
CSPR-07	Mobile Computing	04
CSPR-08	Advanced Networks	04
CSPR-09	Design Patterns and frameworks	04
CSPR-10	Software Metrics	04
CSPR-11	Parallel Numerical Algorithms	04
CSPR-12	Software Requirements And Estimation	04
CSPR-13	Intelligent Agents and Multi-Agents Systems	04
CSPR-14	Wireless and Sensor Networks	04
CSPR-15	Web Technology	04
CSPR-16	Computational Tools and Techniques (Compulsory)	02

** Student can opt any **two** elective papers from CSPR-01to CSPR-15.
** CSPR-16 is compulsory.

COURSE CONTENTS

CSPC-01: High Performance Computing   Credits: 4

HPC infrastructure and trends, Advance analytics for high performances computing, HPC applications, HPC challenge benchmarks, HPCC components, System resources and HPCC, HPL and HPCC benchmarks, Exascale Computing,

Parallel programming paradigms, vectorization, shared-memory and multi-core programming, OpenMP, multi-threading, the Message Passing Interface (MPI), Parallel programs, domain decomposition schemes, communication scheduling methods, parallel linear algebra and parallel solvers, data structures and abstractions, parallel algorithms and libraries, grid computing, resource allocation models.

Suggested Readings:
1. George S. Almasi and Alan Gottlieb, 1993, Highly Parallel Computing. Benjamin/Cumming series.
2. Kai Hwang, 1993, Advanced Computer Architecture: Parallelism, Scalability, Programmability. McGraw Hill.
3. Devid Culler Jaswinder Pal Singh, Morgan Kaufmann, 1999, Parallel Computer Architecture: A hardware/Software Approach.
4. Kai Hwang, 1998, Scalable Parallel Computing. McGraw Hill.
5. William James Dally and Brian Towles, Morgan Kauffman, 2004, Principles and Practices on Interconnection Networks.
6. Hubert Nguyen, GPU Gems 3.
7. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, 2003, Introduction to Parallel Computing, 2nd edition, Addison-Welsey.
8. Petascale Computing: Algorithms and Applications, David A. Bader, Chapman & Hall/CRC Computational Science, 2007.

CSPC-02: Simulation: Theory & Practice   Credits: 3

Introduction to Simulation: Motivation, Types;
Discrete Event Formalisms, Random Number Generation;
Verification and Validation of Simulation Model, Output Analysis.
Application of Simulation Techniques in the areas of Informatics, Business, Economics, Ecology and Social Sciences;
Micro Simulation, Macro Simulation and Agent Based Simulations.
Introduction to Simulation tools and platforms.

Suggested Readings:
1. Banks J., Carson J. S., Nelson B. L., and Nicol D. M., 2001, Discrete Event System Simulation", 3rd edition, Pearson Education.
2. Gordon Geoffrey, 1978, System Simulation, 2nd edition, PHI.
3. Law A. M., and Kelton, W.D., 2000, Simulation Modeling and Analysis, 3rd edition, McGraw-Hill.
4. Narsing Deo, 2004, System Simulation with Digital Computer, PHI.
5. Simulation Modeling: Theory and Practice, Elsevier Journal, Relevant Issues

CSPR-01: Advanced Course in Algorithms   Credits: 4

Review of basic algorithmic techniques and complexities.
Pattern Matching Algorithms
Primality Testing, Integer Factoring, Algorithms for Finite Abelian Groups.
Network Flow and Applications, Matching.
Randomized Algorithms, Load Balancing, Hashing.
NP-Completeness, Approximation Algorithms, Approximation in Local Search.

Linear Programming, LP-duality, Primal-dual Algorithms, semi-definite Programming.
Streaming Algorithms
Online Algorithms and Competitive Analysis
Quantum Algorithms.

Suggested Reading:
1. D.C.Kozen, 1992, The Design and Analysis of Algorithms, Springer-Verlag.
2. J.V.Leeuwen(Ed.), 1990, Handbook of Theoritical Computer Science, Vol.1, Elsevier.
3. N.D.Mermin, 2007, Quantum Computer Science: An Introduction, Cambridge.
4. T.H.Cormen etal, 2002, Introduction to algorithms, PHI.
5. A.Borodin, R.El-Yaniv, 1998, Online Computation and Competitive Analysis, Cambridge University Press.
6. Rajeev Motwani and Prabhakar Raghavan, 1995, Randomizied Algorithms, Cambridge University Press.
7. Michael R.Garey and David S. Johnsonz, , 1979, Computers and Intractability: A Guide to Theory of NP-Completeness, W.H.Freeman.
8. Christos H. Papadimitriou and Kenneth Steiglit , 1982, Combinatorial Optimization Algorithms and Complexity, Prentice Hall.
9. Vijay V. Vazirani, 2001, Approximation Algorithms, Springer.
10. Juraj Hromkovic, 2001, Algorithmics for Hard Problems, Springer.
11. G.Ausiello, et al., 1999, Complexity and Approximation: Combinatorial Optimization Problems and Their Approximability Properties, Springer.

CSPR-02: Computational Intelligence   Credits: 4

Evolutionary Computing Techniques & Hybrid Evolutionary Algorithms, Heuristic
Search, Memetic Algorithms, Swarm Intelligence, Examples.
Artificial Neural Networks, Learning Theory (Supervised, Unsupervised & Reinforced),
Classifiers, Neural Network Optimization, Applications
Rough & Fuzzy Sets, Fuzzy Logic and Inference, Fuzzy Control, Applications.
Selected Topics: Artificial Immune System, Immuno-computing, Granular Computing,
Intelligent Agents, Multi-agent System, Applications.

Suggested Reading:
1. Andries P. Engelbrecht, 2007, Computational Intelligence: An Introduction, Wiley.
2. Eric Bonabeau Guy Theraulaz, Marco Dorigo, 1999, Swarm Intelligence: From Natural To Artificial Systems, Oxford University Press.
3. Dorigo Marco, 2004, Ant Colony Optimization, Prentice-Hall Of India Pvt. Ltd.
4. Gerhard Weiss 2000, Multi-agent Systems: A Modern Approach to Distributed Artificial Intelligence, MIT Press.
5. Jacques Ferber, 1999, Multi-agent systems: An introduction to Distributed Artificial Intelligence, Addison-Wesley.

CSPR-03: Architeture and Design of Software Systems   Credits: 4

Introduction: Software architecture terminology- architecture in the system
development life cycle- architecture dimensions- physical versus logical architectures.
Architectural Viewtypes and Styles: Module viewtypes and styles- component-and-
connector view types and styles- allocation viewtypes and styles-architecture patterns
and frameworks-Evaluating architecture and Architecture based development
Creating an Architecture: Understanding Quality Attributes- Achieving Qualities- Air
Traffic Control: A Case study in Designing for High Availability. Creating the
Architecture- Flight Simulation: A Case Study in an Architecture for Integrability-
Documenting Software Architectures- Reconstructing Software Architectures.
Architecture Representation: Architecture Representation- Data Architectures
Centralized versus distributed databases; -relational versus object oriented databases-

Middleware Technologies- Remote procedure calls-object middleware including DCOM and CORBA-message-oriented middleware.

Web-Based Architectures: Enterprise Java Beans architectures- Microsoft .NET architectures-Software Product Lines: Reusing Architectural Assets- CelsiusTech: A Case Study in Product Line Development-J2EE/EJB: A Case Study of an Industry Standard Computing Infrastructure- The Luther Architecture: A Case Study in Mobile Applications Using J2EE-Building Systems from Off-the-Shelf Components-Software Architecture in the Future.

Suggested Reading:
1. Len Bass, Paul Clements & Rick Kazman, 2003, Software Architecture in Practice, Addison Wesley professional.
2. Frank Buschmann, Regine Meunier, Hans Rohnert, Peter Sommerlad, Miachel Stal,Douglas Schmidt, 2000, Pattern Oriented Software Architecture, John Wiley & Sons.
3. Clements P., Bachmann F, Bass L, Garlan D, Ivers J., Little R., Nord R. and Stafford J., 2002, Documenting Software Architectures: Views and Beyond, Addison Wesley.
4. Mary Shaw and David Garlan, 1996, Software Architecture: Perspectives on an Emerging Discipline, Prentice-Hall.
5. Ian Gorton, 2006, Essential Software Architecture, Springer.
6. Richard N. Taylor, Nenad Medvidovic, and Eric M. Dashofy, 2009, Software Architecture: Foundations, Theory, and Practice, John Wiley & Sons, Inc.

CSPR-04: Data Warehousing and Mining   Credits: 4

Overview: Data warehousing, OLAP and Data mining, Classification of data mining techniques, Discovery and analysis of patterns, trends, and deviations.

Data mining models, Data Mining theory and algorithms, Mathmatical foundations of data mining tools.

Programming data mining algoritjms, Acquiring, parsing, filtering, mining, representing, refining and interacting with data, Data visualization, Clustering, Enabling data mining Techniques, algorithms and applications.

Suggested Readings:
1. Tan, Steinbach, Kumar, 2006, Introduction to Data Mining. Addison-Wesley.
2. Jiawei Han and Micheline Kamber, 2001, Data Mining, Morgan Kaufmann Concepts and Techniques, Academic Press.
3. Ian H. Witen and Eibe Frank, 2000, Data Mining: Practical Machine Learning Tools and Techniques with Java Implementation, Morgan Kaufmann Publisher.

CSPR-05: Grid Computing   Credits: 4

Introduction: Definition - Scope of grid computing

Grid Computing Initiatives: Grid Computing Organizations and their roles – Grid Computing analog – Grid Computing road map.

Grid Computing Applications: Merging the Grid sources – Architecture with the Web Devices Architecture.

Technologies: OGSA – Sample use cases – OGSA platform components – OGSI – OGSA Basic Services.

Grid Computing Tool Kits: Globus Toolkit – Architecture- Programming model- High level services – OGSI-Net middleware Solutions.

Suggested Readings:
1. Joshy Joseph and Craig Fellenstein, PTR-2003, Grid Computing, PHI.
2. Ahmar Abbas, Grid Computing, 2003, A Practical Guide to technology and Applications, Charles River media.

3. Daniel Minoli, 2004, A Networking Approach to Grid Computing, Wiley-Inter science.
4. Mark Baker and Rajkumar Buyya, 1999, Cluster Computing at a Glance, High Performance Cluster Computing: Architectures and Systems (Vol. 1), Prentice Hall, NJ, USA.

CSPR-06: Bioinformatics Computing   Credits: 4

Introduction: The Central Dogma – Killer Application – Parallel Universes – Watson's Definition – Top Down Vs Bottom Up Approach – Information Flow – Conversance – Communications
Search Engines and Data Visualization: Search Process – Technologies – Searching And Information Theory – Computational Methods – Knowledge Management – Sequence Visualizations – Structure Visualizations – User Interfaces – Animation Vs Simulation
Statistics, Data Mining and Pattern Matching: Statistical Concepts – Micro Arrays – Imperfect Data – Basics – Quantifying – Randomness – Data Analysis – Tools Selection – Alignment – Clustering – Classification – Data Mining Methods – Technology – Infrastructure Pattern Recognition – Discovery – Machine Learning – Text Mining – Pattern Matching Fundamentals – Dot Matrix Analysis – Substitution Matrix – Dynamic Programming – Word Method – Bayesian Method – Multiple Sequence Alignment Tools.
Modeling Simulation and Collaboration: Drug Discovery Fundamentals – Protein Structure – System Biology Tools – Collaboration And Communication – Standards – Issues – Case Study.

Suggested Readings:
1. Bryan Bergeron, 2003, Bio Informatics Computing, Prentice Hall.
2. Affward T.K, Parry Smith D.J, 2001, Introduction to Bio Informatics, Pearson Education.
3. Pierre Baldi, Soren Brunak, 2003, Bio Informatics The Machine Learning Approach, 2nd Edition, First East West Press.

CSPR-07: Mobile Computing   Credits: 4

Introduction: Medium Access Control : Motivation for Specialized MAC- SDMA- FDMA- TDMA- CDMA- Comparison of Access mechanisms – Tele communications : GSM- DECT- TETRA – UMTS- IMT-2000
Satellite Systems: Basics- Routing- Localization- Handover- Broadcast Systems: Overview – Cyclic Repetition of Data- Digital Audio Broadcasting – Digital Video Broadcasting
Wireless Local Area Networks: Infrared Vs Radio Transmission – Infrastructure Networks- Ad hoc Networks- IEEE 802.11 – HIPERLAN – Bluetooth.
Wireless Asynchronous Transfer Mode: Motivation for QATM, Wireless ATM working group- WATM services- Reference Model – Functions – Radio Access Layer – Handover- Location Management- Addressing Mobile Quality of Service- Access Point Control Protocol
Mobile Transport Layer and Wap: Traditional TCP- Indirect TCP- Snooping TCP- Mobile TCP- Fast retransmit/ Fast Recovery- Transmission/ Timeout Freezing – Selective Retransmission- Transaction Oriented TCP. WAP - Architecture – Datagram Protocol- Transport Layer Security- Transaction Protocol- Session Protocol- Application Environment.

Suggested Readings:
1. Schiller J, 2006, Mobile Communication, Addison Wesley.
2. William Stallings, 2004, Wireless Communication and Networks, Pearson Education.
3. Singhal, 2005, WAP-Wireless Application Protocol, Pearson Education.

CSPR-08: Advanced Networks   Credits: 4

Fundamentals of Communication Networks: Layers and standards-Packet and circuit switching- Protocols TCP/IP-Ipv6 addressing and routing.-Technical background-Signals and interference- Modulation and encoding-Switching and Multiplexing- Coding and error control.
Network Security: Requirement-Encryption- Decryption- Message authentication and digital signature-Security in IP- QoS principles and protocols-Differential Service-RSVP and MPLS
Internetworking: VLAN-Addressing and routing-network layer protocols-unicast and multicast routing-Mobile IP routing-Ad hoc networks routing-Evolution in the Ethernet-Switched and fast Ethernet-Infrastructure-Scaling to Gigabit architectures-Performance consideration-Physical components and wire protocols.
Optical Networks: Optical layers- Services and interfacing- Photonic packet switching-Access networks-Network survivability- Protection- Optical IP- OTN/SONET/SDH layers structure and design relation to 10 Gigbps Ethernet.
Advanced Topics: SAN (Storage Area Networks) and Infiniband architectures-Home networking- DSL-cable modems- Zero copy systems-Intelligent networks-Future directions.

Suggested Readings:
1. Fourouzan B, 2004, Data Communication and Networking, McGraw-Hill.
2. Ramaswami R and Sivarajan K, 2001, Optical Networks: A Practical Perspective, Morgan Kaufmann.
3. Clark T, 2002, IP SANs, Addison Wesley.
4. Kurose J.F, Ross K.W, 2005, Computer Networking, Top-down Approach Featuring the Internet, Addison Wesley.
5. Tanenbaum A. S, 2003, Computer Networks, Prentice-Hall.
6. Stallings W, 2002, High Speed Networks, Internet Performance and QoS, Prentice-Hall.

CSPR-09: Design Patterns and Frameworks   Credits: 4

Introduction: What Is Design Pattern and Frameworks, Describing Design Patterns and Frameworks, Catalog of Design Patterns and Frameworks, Organizing the Catalog, How Design Patterns Solve Design Problems, How to Select a Design Pattern or a framework, How to Use a Design Pattern or a framework
Creational Patterns: Abstract Factory, Builder, Factory Method
Structural Patterns: Adapter, Bridge, Composite
Behavioral Patterns: Chain of Responsibility, Command, Interpreter

Suggested Readings:
1. Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, 1994, Design Patterns: Elements of Reusable Object-Oriented Software, Addison-Wesley.
2. Eric Freeman, Elisabeth Freeman, Kathy Siera and Bert Bates, 2004, Head First Design Patterns, O'reilly.

CSPR-10: Software Metrics   Credits: 4

Introduction: measurement in everyday life, measurement in software engineering. Goal-based measurement: GQM paradigm, process maturity, measurement validation, Empirical investigation: surveys, case studies and experiments. Software metrics data collection: data, how and when to collect data, how to store and extract data. Analyzing software measurement data: analysis techniques, statistical tests. Measuring internal product attributes: size, structure etc. Measuring external product attributes: quality, reliability, maintainability etc. Measurement for object oriented projects: Lorenz Metrics and Rules of Thumb, CK OO Metrics Suite. Resource management: productivity, teams,

tools etc. Process predictions: Cost estimation, existing modeling methods, planning a measurement program.

Advanced software metrics: Metrics and models for reusable assets, Metrics and models for Reuse-oriented Software development process, CBSE metrics, Software evolution metrics, Software security metrics, Software measurement repositories.

Suggested Readings:
1. N.E. Fenton and S.L. Pfleeger, 2003, Software Metrics- A Rigorous & Practical Approach, 2nd Edition, Thomson Brooks/Cole.
2. S.H. Kan, 2007, Metrics and Models in Software Quality Engineering, 2nd Edition, Pearson Education.

CSPR-11: Parallel Numerical Algorithms   Credits: 4

Introduction to numerical algorithms for parallel computers and their applications, parallel algorithms in numerical linear algebra, dense and sparse solvers for linear systems and the algebraic eigenvalue problems, numerical handling of scientific problems, and numerical optimization techniques.

Suggested Readings:
1. J. J. Dongarra, I. S. Duff, D. C. Sorensen, and H. A. van der Vorst, 1998, Numerical Linear Algebra for High-Performance Computers, SIAM.
2. G. H. Golub and C. F. van Loan, 1996, Matrix Computations, 3rd edition, The Johns Hopkins University Press.
3. C. F. van Loan, 1992, Computational Frameworks for the Fast Fourier Transform, SIAM.

CSPR-12: Software Requirements and Estimation   Credits: 4

Software Requirements, Improving requirements processes, Software requirements and risk management. Software Requirements Engineering: Requirements elicitation, requirements analysis documentation, review, elicitation techniques, analysis models, Software quality attributes, risk reduction through prototyping, setting requirements priorities, verifying requirements quality.

Software Requirements Management: Requirements management Principles and practices, Requirements attributes, Change Management Process, Requirements Tracebility Matrix, Links in requirements chain.

Software Requirements Modeling.

Software Estimation: Components of Software Estimations, Estimation methods. Tools for Requirements Management and Estimation.

Suggested Readings:
1. Karl E. Weigers, 2003, Software Requirements, Microsoft Press.
2. Elizabeth Hull, Ken Jackson and Jeremy Dick, 2006, Requirement Engineering, Springer.
3. Ian Sommerville and Pete Sawyer, 1997, Requirements Engineering: A Good Practice Guide, John Wiley.
4. Karl E. Weigers, 2005, More About Software Requirements: Thorny Issues and Practical Advice, Microsoft Press.
5. Rajesh Naik and Swapna Kishore, 2001, Software Requirements and Estimation, Tata McGraw Hill.
6. S. Withall, 2007, Software Requirement Patterns, Microsoft Press.
7. M. Jogger, 2005, The Software Requirements, Goal Q P C Inc.

CSPR-13: Intelligent Agents and Multi-Agent Systems   Credits: 4

Intelligent Agents
Intelligent Agent and Environment, Structure of Agents: Simple reflex Agents, Model based Reflex Agents, Goal-Based Agents, Utility-Based Agents, Learning Agents; Abstract and Concrete Architecture, Agent programs, Agent Programming languages.

Multi-Agent Systems and Societies of Agents
Communication, Coordination and Cooperation, Working Together, Forming Coalitions, Distributed Problem Solving, Multi-Agent Decision Making, Game Theoretic Formulations, Applications, Distributed Artificial Intelligence, Groupware and Computer Supported Cooperative Work, Agent Based modelling, Computational organization Theory, Applications.

Suggested Readings:
1. Michael Wooldridge, 2009, An Introduction to Multi-Agent Systems, Wiley.
2. Gerhard Weiss, 2000, Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, MIT Press.
3. M.N. Huhns and M.P. Singh, 1997, Readings in Agents, Morgan Kaufmann.
4. N.R. Jennings and M. Wooldridge, 2010, Agent Technology: Foundations, Applications and Markets, Springer-Verlag.
5. M.P. Singh and M.N. Huhns, 2005, Service-Oriented Computing: Semantics, Processes, Agents, John Wiley & Sons.
6. Proceedings of Joint Conferences on Autonomous Agents and Multiagent Systems, ACM.
7. Proceedings of International Conferences on principles and Practices of Multiagent Systems, ACM.

CSPR-14: Wireless and Sensor Networks   Credits: 4

Introduction
Fundamentals of Wireless Communication - Transmission fundamentals - Wireless Communication Technology - Antennas and Propagation, Spread Spectrum, Modulation
Techniques, Coding and Error Control.

Wireless networking, wireless lans & pans
Wireless Networking – Satellite Communication, Cellular Wireless Networks, Mobile IP and Wireless Access Protocol, Wireless LANs -Wireless LAN Technology, IEEE 802.11 Wireless LAN Standards, Bluetooth, HIPERLAN Standard, HomeRF.

Ad-hoc wireless networks & security
Introduction - Issues in Ad Hoc Wireless Networks - Classifications of MAC Protocols - Classifications of Routing Protocols - Classifications of Transport Layer Protocols - Classification of Energy Management Schemes – Wired Equivalent Privacy(WEP) – The Extensible Authentication Protocol - Security in Ad Hoc Wireless Networks.

Wireless sensor networks
Introduction - Sensor Network Architecture - Data Dissemination - Data Gathering - MAC Protocols for Sensor Networks - Location Discovery - Quality of a Sensor Network - Evolving Standards - Other Issues.

Recent advances in wireless networks
Ultra-Wide-Band Radio Communication - Wireless Fidelity Systems - Optical Wireless Networks - The Multimode 802.11 -IEEE 802.11a/b/g - The Meghadoot Architecture - Next-Generation Hybrid Wireless Architectures.

Suggested Readings:
1. William Stallings, 2005, Wireless Communications and Networking, 2nd Edition, Pearson Education.
2. Siva Ram Murthy C, Manoj B.S, 2004, Ad Hoc Wireless Networks: Architectures and Protocols, Prentice Hall.
3. Kaveh Pahlavan and Prashant Krishnamurthy, 2001, Principles of Wireless Networks, Pearson Education.

CSPR-15: Web Technology   Credits: 4

Introduction
Introduction – Network concepts – Web concepts – Internet addresses - Retrieving Data with URL – HTML – DHTML : Cascading Style Sheets - Scripting Languages : Javascript – Vbscript.

Common Gateway Interface
Common Gateway Interface: Programming CGI Scripts – HTML Forms – Custom Database Query Scripts – Server Side Includes – Server security issues – XML.

Java Programming
Java fundamentals: Classes – Inheritance – Packages – Interfaces – Exceptions Handling
– Multi threading – Applets.

Server Side Programming
Server side Programming – Active server pages – Java server pages – Java Servlets: Servlet container – Exceptions – Sessions and Session Tracking – Using Servlet context –
Dynamic Content Generation – Servlet Chaining and Communications.

Applications
Simple applications – Internet Commerce – Database connectivity – Online databases – EDI Applications in Business – Plug-ins – Firewalls

Suggested Readings:
1. Deitel and Deitel, Neito, 2001, INTERNET and WORLD WIDE WEB - How to program, Pearson Education Asia.

CSPR-16: Computational Tools & Techniques   Credits: 2
This is the practical course. The candidates will undergo through hands on training in relevant computational tools/techniques/platforms.

ENVIRONMENTAL SCIENCE & TECHNOLOGY

(Faculty of Science)

Preamble

Ph.D. in Environmental Science & Technology includes a 20 credit course work. These 20 credits are distributed as 3 credits for common courses at the Faculty level, 7 credits for discipline-specific courses and 10 credits for research theme-specific courses. Faculty level courses shall be common for all students. There shall be two common discipline-specific courses, i.e., ETPC-01 and ETPC-02, and one lab work, i.e., ETPC-03. There shall be four research theme-specific courses, i.e., ETPR-02 to ETPR-05, out of which only 2 courses shall be selected by each candidate. ETPR-06 and ETPR-07 shall be common for all and their evaluation shall be done by the concerned RPC. Teaching schedule will be declared in the beginning of the each semester. Details of the courses and their credits are as follows:

OUTLINE

*Student can opt any **two** elective papers from **ETPR-02** to **ETPR-05**.
ETPC-01, ETPC-02, ETPC-03, ETPR-06 and ETPR-07 are compulsory.

Course Code	Title of the paper	Credits
Discipline-Specific Courses		Credits: 7
ETPC-01	Sampling & Analytical Techniques	2
ETPC-02	Recent Advances in Pollution Control Technologies	2
ETPC-03	Lab - work	3
***Research Theme-Specific Courses**		Credits: 10
ETPR-02	Environmental Modeling	3
ETPR-03	Environmental Legislation and Management	3
ETPR-04	Management of Chemical Hazards	3
ETPR-05	Industrial Ecology	3
ETPR-06	Review of literature and presentation of a seminar on a research theme-related topic duly approved by concerned RPC	2
ETPR-07	Preparation and presentation of Research Plan Proposal	2

COURSE CONTENTS

ETPC-01: Sampling & Analytical Techniques   Credits: 2

1. Sampling of air, water, soil and biotic components
2. Principles and applications of HVAS, Portable Gas Sampler, Stack Pollution Controller, Water Sampling Kit, Noise Meter, SOx, NOx, CO, HCs and O_3 Analyzers
3. Principles and applications of Spectrophotometer, Atomic Absorption, Flame photometer, HPLC, Gas Chromatography.
4. Remote sensing techniques, Computation and Statistical Analysis for data synthesis.

Suggested Readings:
1. American Public Health Association, 1998, Standard Methods for the examination of water and wastewater, 18th Ed. American Public Health Association, Washington, D.C.

2. Tripathi B.D. and Govil S.R., 2001, Water Pollution (An Experimental Approach), CBS Publishers & Distributors.

ETPC-02: Recent Advances in Pollution Control Technologies   Credits: 2

1. Principles and operating methodologies of wastewater treatment technologies such as ASP, Upflow Aerobic Sludge Blanket (UASB), Biological Filtration & Oxygenated Reactor (BIOFOR), Fluidized Aerated Bed (FAB) , Oxidation Ponds and Lagoon technologies
2. Principles and operating methodologies of Air pollution control technologies such as ESP, Stack Pollution Controller, Bag filter, Ventury scrubber, Cyclone precipitator & Wet scrubber
3. Recent advances in monitoring and control of Noise Pollution at source, transmission path and the receiver
4. Principles and applications of disinfection techniques such as chlorination, Ozonation, UV and bio-filtration

Suggested Readings:
1. Stanley E. Manhan, 2007, Environmental Science & Technology, Lewis Publishers, New York.
2. Howard S. Peavy, Donald R Rowe, George Tchobanoglous, 1985, Environmental Engineering, McGraw Hill Book Company.

ETPC-03: Lab. Work   Credits: 3
(Based on the above theory papers ETPC-01 and ETPC-02)

Suggested Readings:
1. American Public Health Association, 1998, Standard Methods for the Examination of Water and Wastewater, 18th Edition, American Public Health Association, Washington, D.C.
2. Tripathi B.D. and Govil S.R., 2001, Water Pollution (An Experimental Approach), CBS Publishers & Distributors.

RESEARCH THEME-SPECIFIC COURSES)   Credits: 10
(Any two papers from ETPR-02 – ETPR-05 shall be studied by the candidate.)

ETPR-02: Environmental Modeling   Credits: 3

1. Basic concepts of environmental modeling
2. Scope and limitations of environmental modeling
3. Techniques of air quality modeling
4. Techniques of surface and ground water quality modeling
5. Modeling of hazardous substances
6. Modeling for landscape and urban planning

Suggested Readings:
1. Jo U. Smith, Pete Smith, 2007, Introduction to Environmental Modeling, Oxford University Press.
2. Melli Piero, 1992, Environmental Modeling, Computational Mechanics Publications, Nature.
3. Wainwright John, Mulligan Mark, 2004, Environmental Modeling: Finding Simplicity in Complexity, John Wiley and Sons, Science.

ETPR-03: Environmental Legislation and Management   Credits: 3

1. Important legislations related with environment
2. Duties and responsibilities of citizens for environmental protection
3. Environmental impact assessment (EIA)
4. Cost benefit analysis and environmental audit
5. ISO 14000 standards and certification
6. Process of environmental clearance for establishing industry

Suggested Readings:
1. Sullivan Rory, Wyndham Hugh, 2001, Effective Environmental Management: Principles and Case Studies, Allen & Unwin, Business & Economics.
2. Chris Park, 2001, The Environment: Principles and Application, Routledge Taylor & Francis Group.
3. John Glasson, Riki Therivel and Andrew Chadwick, 2005, Introduction to Environmental Impact Assessment, UCL Press, London
4. Clair N. Sawyer, Perry L. McCarty and Gene F. Parkin, 2003, Chemistry for Environmental Engineering and Science, 5th ed., TATA Mc. Graw Hill

ETPR-04: Management of Chemical Hazards   Credits: 3

1. Chemical hazard in air, water and soil
2. Monitoring and control of chemical hazards
3. Characteristics and hazards of radio- active materials
4. Risk assessment techniques for accidental release of toxic materials
5. Industrial chemical hazards and safety measures
6. Biochemical effects of toxic heavy metals

Suggested Readings:
1. Stanley E. Manhan, 2001, Fundamentals of Environmental Chemistry, Lewis Publishers, New York.
2. Wilson & Walker, 2006, Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press
3. Rae Zimmerman, 1990, Governmental Management of Chemical Risk: Regulatory Processes for Environmental Health, CRC Press.

ETPR-05: Industrial Ecology   Credits: 3

1. Industrial ecology and sustainable industrial development
2. Techniques for eco-leveling, inventory analysis and input/output models.
3. Material flow analysis and dematerialization
4. Scope of Environmental Management System in industries
5. Recycling of waste materials in industries
6. Scope of green belt development in and around industrial zones

Suggested Readings:
1. Bourg Dominique, Erkman Suren, 2003, Perspectives on Industrial Ecology, Greenleaf Publishing.
2. Manahan Stanley E., 1999, Industrial Ecology: Environmental Chemistry and Hazardous Waste, CRC Press.
3. R. Allenby Braden, 1999, Industrial Ecology: Policy Framework and Implementation, Prentice Hall.

*ETPR-06: Preparation and presentation of the Research Plan Proposal   Credits: 2

*ETPR-07: Review of literature & presentation of a seminar on research theme
<div align="right">Credits: 2</div>

(*Evaluation shall be done by the concerned RPC)

Geography

(Department of Geography)

Preamble

The student admitted for Ph. D in Geography is required to pass a course of minimum 20 credits. The Ph.D course in Geography will cover **(A) Faculty-level Compulsory Courses (3 credits)**, **(B) Discipline - specific courses (7 credits)** and **(C) Research-Theme Specific Courses (10 credits).** The discipline - specific course will consist of two papers (one theory: 4 credits and one practical: 3 credits). The research- theme specific course will have four papers (two optional papers and two compulsory papers including Research Plan Proposal). Each student is required to opt any two elective papers out of the list of fifteen papers (GRPR-01 to GRPR-15). The elective papers will be decided by the respective RPC. The research plan proposal (write up) and its presentation will be evaluated by the concerned RPC.

OUTLINE

Course Code	Title of Paper	Credit
Discipline-Specific Courses		Credits: 7
GRPC-01	Research Strategy and Orientation in Geography	4
GRPC-02	Application of methods and techniques in Geographical Studies (Practical)	3
** **Research Theme-Specific Courses**		Credits: 10
GRPR-01	Advances in Geomorphology	3
GRPR-02	Applied Climatology	3
GRPR-03	Applied Hydrology	3
GRPR-04	Remote Sensing & GIS as Tools in Geographical Research	3
GRPR-05	Environmental Problems and Strategic Management	3
GRPR-06	Population Dynamics and Family Welfare Programme	3
GRPR-07	Geography of Human Resource Development	3
GRPR-08	Rural Geography: Theory and Practice	3
GRPR-09	Urban Studies	3
GRPR-10	Peri-Urban Interface and Its Dynamics	3
GRPR-11	Regional Development and Globalisation	3
GRPR-12	Industrialisation and Regional Development	3
GRPR-13	Agriculture Geography and Rural Development	3
GRPR-14	Geography of Tourism and Heritage	3
GRPR-15	Geography of Health and Ecology	3
GRPR-16	Field Survey and Analysis	2
GRPR-17	Research Proposal: Preparation and Presentation	2

** Student can opt any **two** elective papers from GRPR-01 to GRPR15.
** GRPR16 & GRPR17 are compulsory.

GRPC-01: Research Strategy & Orientation in Geography   Credits: 4

UNIT I
Planning research: Data sources: collection and generation; Primary data and Secondary data; Data collection and arrangement; Collection of data: methods, sources and types; Data processing; Characteristics and component of a computer system.

UNIT II
Research design: Participatory research; Sampling: methods, techniques and procedures; Making and designing of Survey-questionnaire; Variables and indices: selection, identification and application.

UNIT III
Data interpretation: Production and arrangement of data; Classification and tabulation of data; Analysis of data and maps; Model making.

UNIT IV
Theoretical Construction: Appraisal of System theory; Quantitative and Qualitative interpretations; Framing pilot/ research project; Application and relevance of statistical and cartographic techniques.

Suggested Readings:
1. Ahuja, Ram, 2001, Research Methods. Rawat Publications, Jaipur and New Delhi.
2. N. K. Denzin and Y. S. Lincoln, 2000, Handbook of Qualitative Research. Sage Publ., Thousand Oaks CA.
3. R. Flowerdew and D. Martin, 1997, Methods in Human Geography. A Guide for Students Doing a Research Project. Longman, Harlow.
4. Iain Hay, 2004, Communicating in Geography and the Environmental Sciences, 2nd Edition, Oxford University Press, Melbourne.
5. Iain Hay, 2005, Qualitative Research Methods in Human Geography, 2nd Edition, Oxford University Press, Melbourne.
6. Rob Kitchen, and Duncan Fuller, 2005, The Academic's Guide to Publishing. Vistaar Publs. (Sage), New Delhi.
7. Mclanie Limb, 2001, Qualitative Methodologies for Geographers. Issue and Debates. Arnold, London.
8. J. F. Lousenbury and F. T. Aldrich, 1986, Introduction to Geographic Field Methods and Techniques. Charles E. Merrill Publishing. Company, Colombus.
9. B. Mikkelsen, 1995, Methods for Development Work and Research: A Guide for Practitioners. Sage, London.
10. Neela Mukherjee, 2002, Participatory Learning and Action: with 100 Field Methods. Concept Publs. Co., New Delhi.
11. Tony Parsons and Peter G. Knight, 2005, How to do your Dissertation in Geography and Related Disciplines,2nd Edition, Routledge, London.
12. Robert H. Stoddard, 1982. Field Techniques and Research Methods in Geography. Kendall/Hunt Pub. Dubuque IO.

GRPC-02: Practical: Application of Methods and Techniques in Geographical studies   Credits: 3

1. Application and relevance of statistical and cartographic techniques
2. Application of computer, remote sensing, GIS and GPS; and
3. Framing Pilot/ research project; use of writing manuals

GRPR-01: Advances in Geomorphology   Credits: 3

Unit I
A critical analysis of fundamental concepts; Concept of Dynamic Equilibrium versus Davis' and Penck's concepts; Time, Space and Causality in Geomorphology; Recent Trends in Geomorphology

Unit II
Climatic Geomorphology; Environmental Geomorphology; Mapping Techniques in Geomorphology; Systems in Geomorphology; Models in Geomorphology

Unit III
Geomorphology and Economic Deposits; Geomorphology in Ground water studies; Geomorphology in Soil Studies and Mapping; Geomorphology in Engineering Construction; Alluvial Fans and Flood Plains—their morphology, materials and Processes.

Suggested Readings:
1. Robert J. Allison, 2002, Applied Geomorphology: Theory and Practice. John Wiley, Chichester UK.
2. A. L. Bloom, 1998/ 2001. Geomorphology, 3rd edition, Prentice Hall of India, New Delhi.
3. Andrew Goudie, 2004, Encyclopedia of Geomorphology, Volume 2, Routledge, London.
4. S. R. Jog, 1995, Indian Geomorphology, 2 volumes, Rawat Publications, Jaipur
5. V. Kale, and A. Gupta, 2001, Introduction to Geomorphology, Orient Longman, Hyderabad.
6. G. Kondolf, Mathias and Piégay, Hervé, 2003, Tools in Fluvial Geomorphology, John Wiley, Chichester UK.
7. Mauro Marchetti and Victoria Rivas, 2001, Geomorphology and Environmental Impact Assessment, Swets & Zeitlinger, the Netherlands.
8. W.D. Thornbury, 2005, Principles of Geomorphology, John Wiley, New York

GRPR-02: Applied Climatology   Credits: 3

Unit I
Meaning and Scope of Climatology, Difference between weather and climate, climatology and meteorology, elements of weather and climate, Temperature: their distribution and controlling factors, laws of horizontal motion of air and general atmospheric circulation

Unit II
Monsoon, jet streams and their significance with reference to India, precipitation: spatio-temporal variation and distribution in India, Tropical Cyclone: origin and associated weather, climatic classification: Koppen and Thorthwaite.

Unit III
Water balance parameters and their use in climatic classification, seasonal computation of aridity, humidity and moisture indices and their application in crop and irrigation management, agro-climatic regions of India: delineation and characteristics, climatic change: evidences and theories, global warming: causes and consequences.

Suggested Readings:
1. R.G. Barry and M. Carleton, 2001, Synoptic and Dynamic Climatology, Routledge, London.
2. R.J. Chorley, 2001, Atmosphere, Weather and Climate, Methuen, London.
3. H.J. Critchfield, 2002, General Climatology, Prentice-Hall of India, New Delhi.
4. J.E. Oliver and J.J. Hidore, 2003, Climatology: An Atmospheric Science, Pearson Education Private Ltd, Patparganj, Delhi.

5. P. J. Robinson and S. Henderson, 1999, Contemporary Climatology, 2nd Edition, Pearson Education Ltd., Harlow, UK.
6. M.B. Singh, 1998, Jalvayu Avam Samudra Vigyan, Tara Book Agency, Varanasi.
7. S. Singh, 2005, Climatology, Prayag Pustak Bhawan, Allahabad.

GRPR-03: Applied Hydrology   Credits: 3

Unit I
Hydrology as emerging discipline of earth science, hydrological cycle, man's intervention in hydrological cycle, major components of hydrological cycle: precipitation, evapotranspiration, infiltration, surface and ground water runoff.

Unit II
Hydrograph: components and separation, unit hydrograph, estimation of evapotranspiration, river basin/water shed as planning unit for integrated water resource development and management, conservation of water resources.

Unit III
Water crisis in India, water resource management in India with special reference to irrigation for food security, problems associated with water: droughts and floods in India, water balance graph and its application with special reference to seasonal crop management.

Suggested Readings:
1. Philip B. Bedient and Wayne Charles Huber, 2002, Hydrology and Floodplain Analysis, Prentice Hall, Englewood Cliffs NJ.
2. R. J. Chorley, 1995, Atmosphere, Weather and Climate, Methuen and Company Ltd., London.
3. Von Te Chow, David R. Maidment and Larry W. Mays, 1988, Applied Hydrology, McGraw-Hill, New York.
4. C. W. Fetter, 2001, Applied Hydrogeology, Pearson Education, San Francisco.
5. Neven Krešić, 2008, Groundwater Resources: Sustainability, Management, and Restoration, McGraw Hill Professional, New York.
6. D. J. Poehls and Gregory John Smith, 2009, Encyclopedic Dictionary of Hydrogeology, Academic Press, New York.
7. Franklin W. Schwartz and Hubao Zhang, 2003, Fundamentals of Ground Water, Wiley Science, Chichester UK.
8. M. B. Singh, 1999, Climatology and Hydrology, Tara Book Agency, Varanasi.
9. S. Singh, 2008, Climatology, Prayag Pustak Bhawan, Allahabad
10. R.C. Ward and M. Robinson, 2000, Principles of Hydrology, McGraw Hill, New York.

GRPR-04:   Remote Sensing & GIS as Tools in Geographical Research   Credits: 3

Unit I
Nature of Geographical Data; Conventional methods of geographical data collection vis-à-vis remote sensing and GIS; Some aspects of geodesy of earth and their implications in GIS; Spectra of common natural objects; Mechanism of remote sensing data acquisition.

Unit II
Models of geographic data representation in GIS; Spatial data quality and error analysis; Conceptual and Logical Data Modelling; Some important characteristics of Remote Sensing Data; Nature of image patterns and their interpretation

Unit III
DEM and Derivatives; GIS as spatial decision support system; Information extraction procedures from remote sensing data—manual and digital; Application of remote

sensing and GIS in Land use, hydro-geomorphologic and integrated rural and urban development studies.

Suggested Readings:
1. P.A. Burrough and R. McDonnell, 1998, Principles of Geographic Information Systems, Oxford University Press, Oxford.
2. J. B. Campell, 2003, Introduction to Remote Sensing, 4th Edition, Taylor and Francis, London.
3. K.T. Chang, 2003, Introduction to Geographic Information Systems, Tata McGraw Hill Publications Company, New Delhi.
4. M. N. Demers, 2000, Fundamentals of Geographic Information Systems, John Wiley and Sons, Singapore.
5. N.C. Gautam and V. Raghavswamy, 2004, Land Use/ Land Cover and Management Practices in India, B.S. Publications., Hyderabad.
6. M. C. Girard and C. M. Girard, 2003, Processing of Remote Sensing Data, Oxford and IBH, New Delhi.
7. I. Heywood, 2003, An Introduction to Geographical Information Systems, 2nd Edition, Pearson Publishing Company, Singapore.
8. J.R. Jensen, 2004, Remote Sensing of the Environment: An Earth Resource Perspective, Prentice-Hall, Englewood Cliffs, New Jersey.
9. T.M. Lillesand and R.W. Kiefer, 2000, Remote Sensing and Image Interpretation, John Wiley and Sons, New York.
10. C.P. Lo and A. K. W. Yeung, 2002, Concepts and Techniques of Geographic Information Systems, Prentice Hall of India, New Delhi.
11. P. Longley, M. F. Goodchild, D. Maguire and D. Rhind, 1999, Geographic Information Systems, Principles, Techniques, Management, Applications, John Wiley and Sons, New York.

GRPR-05: Environmental Problems and Strategic Management   Credits: 3

Unit I
Introduction: Meaning and Concept of Environment, Pollution, Types of Pollution and Environmental Degradation; Environmental Quality Indices: Air, Water, Soil, Noise and Solid Waste; Environmental Management: Meaning ,Concept and Approaches

Unit II
Environmental Problems: Environmental Problems at Global, National and Regional level: Air Pollution and Global Climatic Change, Water Pollution and its Crisis, Land Degradation and Biodiversity, Natural Hazard and Mapping; Human Response and Attitude towards Environmental Problems; Environmental Quality and Health

Unit III
Environmental Management: Strategies for Environmental Management, Environmental Monitoring, Environmental Education and People's Participation, Environmental Laws and Role of International Bodies, EIA of Development Schemes: some case studies, National Environmental Policy.

Suggested Readings:
1. Y. Anjaneyulu, 2002, Environmental Impact Assessment Methodology, B.S Publications, Hyderabad
2. J. Blodgett, 2000, Environmental Protection: New Approaches, CRS Report, National Council for Science and the Environment
3. C. Copeland, 2006, Water Quality: Implementing the Clean Water Act, CRS Report, National Council for Science and the Environment
4. W. Cruz, and C. Gills, 1990, Resource Policy Reform in the Context of Population Pressure in D. Chapman, Arresting Renewable Resource Degradation in the Third World. World Bank Environment Working Paper No. 44. Washington, DC: the World Bank

5. J. E. Hardoy, 1997, Environmental Problems in Third World Cities, Earthscan Publications limited, London
6. P. Nag, V. K. Kumra and J. Singh, 1997, Geography and Environment: National, Regional and Local Issues, 3 Volumes, Concept Publishing Company, New Delhi
7. M. B. Singh, 2005, Sustainable Management of Natural Resources (Land, Water and Forest), Tara Book Agency, Varanasi.
8. S. K. Singh, 2010, Strategic Management of Energy, Environment and Disaster for Sustainable Management, Proceedings of the International Conference on Strategic Management of Energy, Environment and Disaster for Sustainable Management, Faculty of Management Studies, BHU, Varanasi, January 11-15 2010.

GRPR-06: Population Dynamics and Family Welfare Programmes   Credits: 3

Unit I
Introduction and Conceptualization. Concept and Components of Population Dynamics; Distribution of Population; Population Growth: Trends and Theories; Mortality Patterns and Trends; HIV/AIDS Pandemic, Fertility: Trend, Patterns and Determinants; Migration: Trends and Patterns; Population and Resource Relationship; World Population: Major Issues for the 21st century.

Unit II
A Case Study of India. Population Dynamics: Regional Variation and Determinants; Fertility, Mortality and Migration: Trend and Determinant, Urbanization: Challenges and Opportunities; Population Dividend for India; Comparative Analysis of Kerala and U.P.; Family Welfare Programmes in India: A Critical Appraisal; National Population Policy 2000; Comparative Study of Population Policies: India and China.

Unit III
Measures and Indices. Data Sources, Error & Adjustment; Measures of Population change (arithmetic, geometric and exponential) and distribution (density, population potential, Lorenze curve); Measures of Mortality: Adjusted and Unadjusted and Lifetable); Measures of period and Cohort Fertility, Measures and Models of Migration (indirect estimation of internal migration and Ravenstein's law, Zipf's gravity, Todaro's rural-urban); Population Estimates and Projections.

Suggested Readings:
1. Nab Kishore Behura and Ramesh P. Mohanty, 2005, Family Welfare in India: A Cross-Cultural Study, Discovery Publs. House, New Delhi.
2. R. Cassen, 1994, Population and Development: Old Debates, New Conclusions, Transaction Publishers, New Brunswick and Oxford.
3. Shanta Kohli Chandra, 1987, Family Planning Programme in India: Its Impact in Rural and Urban Areas, Mittal Publs., New Delhi.
4. C.Y. Cyrus Chu, 1998, Population Dynamics: A New Economic Approach, Oxford University Press, New York.
5. Dyson, Tim; Cassen, Robert and Visaria, Leela, 2005, Twenty-First Century India: Population, Economy, Human Development, and the Environment, Oxford University Press, Oxford and New Delhi.
6. Christophe Guilmoto and Sebastian I. Rajan, 2005, Fertility Transition in South India, Sage, New Delhi and London.
7. Diana Hummel, 2008, Population Dynamics and Supply Systems: A Transdisciplinary Approach, Campus Verlag, Frankfurt.
8. Lori M. Hunter, 2000, The Environmental Implications of Population Dynamics, Rand Corporation, New York.
9. Helen M. Macbeth, and Paul Collinson, 2002, Human Population Dynamics: Cross-Disciplinary Perspectives, Cambridge University Press, Cambridge.
10. Narayanan Krishnan Namboodiri, 1996, A Primer of Population Dynamics, Springer, New York.

11. Venkatesh Srinivasan, 2001, Health and Family Welfare Programmes in Developing Countries: Study of Innovations in an Indian State, Aalekh Publishers, New Delhi.
12. Peter Turchin, 2003, Complex Population Dynamics: A Theoretical/Empirical Synthesis, Princeton University Press, Princeton.

GRPR-07: Geography of Human Resource Development   Credits: 3

Unit I
Nature, scope and significance of Human Resource Development; Definition and classification of Human Resources, Human Resource Development, Human Development and Human Resource Utilization; Human Resource Development in space and time; Dimensions and characteristics of Human Resources Development – Quantitative and Qualitative; Process of human resource development.

Unit II
Concepts and Methods in studying Human Resource Development; Human Resource Development Indicators relating to Literacy, education, health, disease, food and nutrition, etc.; Types and sources of human resource development data; Managing human resource development data and devising indices; Concept and Computation of HRD or HDI; Amenities and Planning for human resources development.

Unit III
Problems of Human Resource Development; Spatial and Societal variation in human resource development; Human Resources in India: Potential, Utilized and Un-utilized; Development and Utilization of Primary, Secondary and Tertiary Human Resources in India; Deterioration and Conservation of Human Resources; Human Resources Development, Quality of life and Social well being.

Suggested Readings:
1. Pawan S. Budhwar and Yaw A. Debrah, 2004, Managing Human Resources in Asia-Pacific. Rouledge, London and New Delhi.
2. Jerry W. Gilley, Steven A. Eggland, Ann Maycunich and Ann Maycunich Gilley, 2003, Principles of Human Resource Development, Perseus, New York.
3. Pat Hargreaves and Peter Jarvis, 2000, The Human Resource Development Handbook, Kogan Page Publishers, London.
4. Jennifer Joy-Matthews, David Megginson and Mark Surtees, 2004, Human Resource Development, 3rd Edition, Kogan Page Publishers, London.
5. Parminder Kaul, 1996, Human Resource Development for Rural Development, Arnold Publication Ltd., New Delhi.
6. Chris Rowley and John Benson, 2004, The Management of Human Resources in the Asia Pacific Region: Convergence Reconsidered, Frank Cass Publ., London.
7. Ronald R. Sims, 2006, Human Resource Development: Today and Tomorrow, Information Age Publications, San Francisco.
8. Sanjeev Kumar Singh, 2008, Human Resource Development, Atlantic Pub. Gr., New Delhi.
9. Richard A. Swanson and Elwood F. Holton, 2009, Foundations of Human Resource Development, 2nd Edition, Berrett Koehler Publ., San Francisco.
10. Jon M. Werner and Randy L. DeSimone, 2008, Human Resource Development, 5th Edition, South-Western (Cengage) Publ., Mason OH.
11. Michael Zanko, 2002, The Handbook of Human Resource Management Policies and Practices in Asia-Pacific Economies, Volume 1, Edward Elgar Publ., Cheltenham UK.

GRPR-08: Rural Geography: Theory and Practice   Credits: 3

UNIT I
Rural communities; Rural space, society, and rurality; Governanance and globalization; Revisiting landownership and property rights; Theories and Models of rural settlement and its diffusion.

UNIT II
Theorization of culture, politics, space and poverty in rural contexts; Rise of productivist farming ways of conceptualising agricultural change; Institutional-strengthening issues; Rural future and globalisation; Food supply and food security; Challenges of sustainability.

UNIT III.
[**Indian Scenario]--** Indian Village: Concept, attributes, and historical context and multiplicity; Regional morphological characteristics; Morphological interaction models: Religio-ritual, Secular-economic, Rural Housing and Architicture Rural-urban linkages: Peri-urban interface; Role of service centres; Transformation and Planning of Indian village: models and plans.

Suggested Readings:
1. Brij Raj Chauhan, 2009, Rural Life: Grass Roots Perspectives: Based on Field Experiences and Assessment of Published Work over Eight Decades of Intensive Studies in Villages of Uttar Pradesh, Concept Publishing Co., New Delhi.
2. Paul J. Cloke, Terry Marsden and Patrick H. Mooney, 2006, Handbook of Rural Studies, Sage, London.
3. Hugh D. Clout and R. J. C. Munton, 2007, Contemporary Rural Geographies: Land, Property, and Resources In Britain, Routledge, London.
4. Stephen Essex, 2005, Rural Change and Sustainability: Agriculture, The Environment and Communities, CABI International, Oxfordshire UK.
5. Nick Gallent, Meri Juntti and Sue Kidd, 2008, Introduction to Rural Planning, Routledge, London.
6. Lewis Holloway and Moya Kneafsey, 2004, Geographies of Rural Cultures and Societies, Ashgate Publishing, Aldershot UK.
7. Joe Morris, 2001, Rural Planning and Management, Managing the Environment for Sustainable Development series, Edward Elgar Publishing, Cheltenham UK.
8. Michael Woods, 2005, Rural Geography: Processes, Responses and Experiences in Rural Restructuring, Sage, London.
9. Michael Woods, 2010, Rural (Key Ideas in Geography), Routledge, London.

GRPR-09: Urban Studies   Credits: 3

Unit I
Conceptual Issues in Urban Studies: Urbanisation in Space and Time; Theories and Approaches of Urban Studies: Locational, Regional, Spatio-structural, eco system and environmental perception; Dimensions of urban studies in India: geographical and non geographical; problem ,policy, sand evaluation oriented.

Unit II
Urban Issues and Challenges: Urban society: Urban Structure, Social Space and urban crime; Urban environment: water, sanitation, solid waste and slums; urban economy.s

Unit III
Urban Management and Governance: Urban planning: Governance and Managements; urban development policies; Implications of 74th CAA on urban governance; Future governance structure: PPP, capacity building for better service delivery.

Suggested Readings:
1. Ashok Dutt, 1994, The Asian Cities: Processes of Development, Characteristics and Planning, GeoJournal Library, London.
2. HUDCO-HSMI, 2001, The States of Indian Cities, HUDCO HSMI, New Delhi.
3. R. Jha and Nasreen Siddiqui, 2000, Towards People Friendly Cities, UNICEF Maharastra State Office, Mumbai.
4. Paul Knox and Steven Pinch, 2006, Urban Social Geography, 5th Edition, Pearson Prentice-Hall, Englewood Cliffs NJ.
5. B. Kumar and R. B. Singh, 2003, Urban Development and Anthropogenic Climatic Change, Manak Publications, New Delhi.
6. A. Kundu, 2005, Urban Development and Urban Research in India, Khama Publishers, New Delhi.
7. Michael Pacione, 2005, Urban Geography: A Global Perspective, 2nd Edition, Routledge, London.
8. R. P. Misra and K. Misra, 1998, Million Cities of India, Vol.I/II, Sustainable Foundation, New Delhi.
9. K. C. Sivaramakrishnan, 2005, A Hand Book of Urbanisation in India, Oxford University Press, New Delhi.
10. UNCHS-UN HABITAT, 2001, Cities in a Globalising World, Global Report on Human Settlement, Earthscan, London and Sterling, VA.

GRPR-10: Peri-Urban Interface and Its Dynamics   Credits: 3

Unit I
Theoretical Base. Evolution of the PUIs; Basic concepts: urban, rural, urbanization, urban growth, urban sprawl, spatial hybridization, etc.; Typology and processes; PUI Studies: major trends and emerging issues; Methodologies and techniques: qualitative, quantitative, and GIS & Remote Sensing; Approaches: descriptive, explanatory, normative, critical, participatory, and predictive.

Unit II
Application. PUIs and their characteristics: developed vs. developing world; Migration, urbanization and peri-urbanization; Production systems in the PUIs; the PUI impacts land use, biodiversity, environment, agriculture, resources, livelihood, and infrastructure. and conflicts; Challenges: management, planning, and sustainability.

Unit III
Indian Scenario. Metropolization and Peri-Urban growth; Metropolitan growth: regional comparison; Impacts in PUIs: Land use, environmental, resources livelihood, infrastructure; Peri-urban governance; Case studies: Delhi, Chennai, Varanasi.

Suggested Readings:
1. R. M. Brook and J. D. Dávila, 2000, The Peri-Urban Interface: A Tale of Two Cities. School of Agricultural and Forest Sciences, University of Wales and Development Planning Unit, University College London.
2. R. Brook, S. Purushothaman & C. Hunshal, 2003, *Changing Frontiers—The Peri Urban Interface Hubli Dharwad, India.* Books for Change, Bangalore.
3. T. Champion & G. Hugo, 2004, *New Forms of Urbanization: Beyond the Urban-Rural Dichotomy*, Ashgate, Aldershot.
4. Véronique Dupont & N. Sridharan, 2006, Peri-Urban Dynamics: Case Studies in Chennai, Hyderabad and Mumbai, CSH Occasional Paper No. 17. Publication of the French Research Institute in India, New Delhi.
5. Keith Hoggart, 2005, *The City's Hinterland: Dynamism and Divergernce in Europe's Peri-Urban Territories Perspectives on Rural Policy and Planning,* Ashgate, Aldershot.
6. D. McGregor, D. Simon and D. Thompson, 2006, *Peri-Urban Interface: Approaches to Sustainable Natural and Human Resource Use,* Earthscan Publications Ltd., London, UK.

GRPR-11: Regional Development and Globalisation   Credits: 3

UNIT I
Conceptual Issues: Process of globalisation; Impact of Globalisation in different sphere of economic and political life; Changing paradigm of Planning in Post-globalised era; Changing Nature of State Intervention and Process of Regional Development; Natural, Economic and Planning Regions; Aspects of Concentration and Dispersal of economic activities Polarization and Spread. ; Multiplier Effect in Spatial terms; Regional variation in productivity of capital and labour; Diversity and Disparity.

UNIT II
Theories: Spatial aspect of development: a. Basic Theories of Spatial Economic Structure – Richardson and Smith; b. Dependency Theory – Andre Günter Frank; c. World System Approach – Wallerstien and Samir Amin; d. Linkage between World-Trade and Regional Development – Krugman

UNIT III
Measurement of Developmental Processes and Examples: Dimensions, Variables and Indicators; Choice of indicators; Alternative approaches of compositing of different indicators: Principal Component Analysis; Gravity Model; Simulations; Input-output Model; Regionalisation – Clustering; Process of Economic Concentration and Relocation - China, Venezuela, India; Problem Regions- Eastern UP, Bundelkhand; Regional policy of Balanced development.

Suggested Readings:
1. J. Behrman and T. N. Srinivas, 1998, *Handbook of Development Economics*, Vol. III
2. B. Berberoglu, 1992, *The Political Economy of Development*, State University of New York Press.
3. L. S. Bhat, 2003, *Micro Planning: A Case Study of Karnal Area*, KB Publs., New Delhi.
4. R. P. Misra, 2002. Regional Planning, Concepts, Techniques, Policies and Case Studies. Concept Publishing Company, New Delhi.
5. P. Saunders, 1998, Capitalism: A Social Audit, World View.
6. P. R. Sharma, 1994, *Regional Policies and Development in the Third World*, Rishi Publications, Varanasi.

GRPR-12: Industrialization and Regional Development   Credits: 3

Unit I
Concepts and Theories: Meaning of industrialization; Processes of industrialization; Structuralist view, Neo-classical view, Radical view; Theories of industrial location — Weber, Smith and Allen Pred; Industrial linkages, Role of industries in regional development.

Unit II
Techniques of Spatial and Structural Analysis: Indicators of industrialization; Location Quotient, Localization Coefficient and Localization Curve; Regional specialization and Diversification; Level of industrialization.

Unit III
Industrialization in India: Evolution and growth of industries; Industrial regions and complexes; Factors and trend of regional diversification, Industrial policies, Rural industrialization, Industries and environmental degradation.

Suggested Readings:
1. G. L. Clark, M. S. Gertler and M. P. Feldman, 2000, The Oxford Handbook of Economic Geography, Oxford University Press, USA.

2. R. Hudson, 2005, *Economic Geographies: Circuits*, Flows and Spaces, Sage Publications, London.
3. P. Krugman, 1995, *Development, Geography, and Economic Theory,* Cambridge: MIT Press.
4. D. Mackinnon and A. Cumbers, 2007, *Introduction to Economic Geography: Globalization, Uneven Development and Place,* Prentice Hall, Inc., New York
5. P. Mathur and S. Kalia, 2005, *Fundamentals of Industrial Geography*, Ritu Publications, Jaipur,
6. V. N. Sharma, 2001, *Industrial Development and Planning in India*, Radha Publications, New Delhi.
7. E. Sheppard and T.J. Barnes, 2002, *A Companion to Economic Geography,* Blackwell Publishers, Inc., Massachusetts.

GRPR-13: Agriculture Geography and Rural Development　　　　Credits: 3

Unit I
Concepts, approaches and methodology of agricultural geography; Agricultural land-use and carrying capacity; Measures of agricultural efficiency and agricultural productivity. Agro-climatic regions of India, Green revolution in India; Second generation reforms in Indian agriculture, Agricultural planning and policies in India.

Unit II
Concept and approach of rural development: Five Year Plans and rural development in India; rural development policies and programmes: Integrated area development and rural development programmes; rural development planning: problem, policy and target group oriented approach.

Unit III
Rural development and poverty amelioration in India; Five Year Plans and poverty removal strategy and planning; poverty and rural development target groups and planning in India; policy, programme and implementation at the local level planning/micro level planning; People's participation in rural development and planning; role of Panchayati Raj.

Suggested Readings:
1. J. Krishnamurthy, 2000, Rural Development. Problems and Prospects, Rawat Publications, Jaipur.
2. R. P. Misra and R. N. Achyutha, 1998, Micro-Level Rural Planning: Principles, Methods and Case Studies, Concept Publishing. Company, New Delhi
3. M. Shafi, 2006, Agricultural Geography, Pearson Education, New Delhi.
4. J. Singh, and S. S. Dhillon, 2000, Agricultural Geography, Tata McGraw Hill, New Delhi.
5. S. Singh, 1994, Agricultural Development in India: A Regional Analysis, Kaushal Publications, Shillong.

GRPR-14: Geography of Tourism and Heritage　　　　Credits: 3

Unit I
Development of the Geography of Tourism and Heritage; Basic concepts: Tourism studies: Concepts and Principles; Methodologies and Approaches:

Unit II
Geography of Tourism: National, Regional and Global scenarios; Alternative tourism and Prospects: Ecotourism, Sustainable tourism, Heritage Tourism; Tourism Management, heritage issues and prospects: policy and planning - global, and national.

Unit III

Indian Scenario:- Tourism and Heritage resources, Tourism as industry and economy: national, state and local contexts; Heritage Planning and Master Plan, Varanasi: Heritage Zoning, identification and planning,s Types of tourism: domestic, international, local, pilgrimages; Tourism policies, perspectives, and plans.

Suggested Readings:
1. Cara Aitchison, Nicola E. MacLeod and Stephen J. Shaw, 2000, Leisure and Tourism Landscape: Social and Cultural Geographies, Routledge, London.
2. G. J. Ashworth and A.G.J. Dietvorst, 1995, Tourism and Spatial Transformations: Implications for Policy and Planning, CAB International, Warwick UK.
3. Luigi F. Girard and Peter Nijkamp, 2009, Cultural Tourism and Sustainable Local Development, Ashgate Publ., Farnham U.K.
4. Stefan Gössling, C. Michael Hall and David Weaver, 2008, Sustainable Tourism Futures: Perspectives on Systems, Restructuring and Innovations, Routledge, London.
5. C. M. Hall and S. J. Page, 2008, The Geography of Tourism and Recreation: Environment, Place and Space, 4th Edition, Routledge, London.
6. Carol Henderson and Maxine Weisgrau, 2007, Raj Rhapsodies: Tourism, Heritage and Seduction of History, Ashgate Publ., Farnham U.K.
7. James Higham, 2007, Critical Issues in Ecotourism: Understanding a Complex Tourism Phenomenon, Butterworth-Heinemann, Oxford.
8. Martha Honey, 2008, Ecotourism and Sustainable Development, Island Press, Seattle.
9. Tazim Jamal and Mike Robinson, 2009, The SAGE Handbook of Tourism Studies, Sage, London.
10. Douglas Pearce and Richard W. Butler, 1999, Contemporary Issues in Tourism Development, Routledge, London.
11. Razaq Raj and Nigel D. Morpeth, 2007, Religious Tourism and Pilgrimage Festivals Management: An International Perspective, CABI, London.
12. Rana P. B. Singh, 2009, Banaras, Making of India's Heritage City, Cambridge Scholars Publishing, Newcastle upon Tyne UK.
13. Rana P. B. Singh, 2009, Where the Buddha Walked, A Companion to the Buddhist Places of India, 2nd Edition, Indica Books, Varanasi.
14. Rana P. B. Singh and Pravin S. Rana, 2009, Banaras Region: a Spiritual and Cultural Guide, 2nd Edition, Indica Books, Varanasi.
15. Dallen J. Timothy, 2007, The International Library of Essays in Tourism, Heritage and Culture: 3-Volume Set, Ashgate Publ., Farnham U.K.

GRPR-15: Geography of Health and Ecology   Credits: 3

UNIT I

Concept of mortality, morbidity and health; Political economy of health; Colonial and Post-colonial concepts of health ; Health as a commodity; Quality of life; Social capital approach to health-care; Market, State and Social Opportunity; Linkage between health and ecology; Political ecology of disease and its scope.

UNIT II

Pattern of morbidity- global and national; Geographical aspect of distribution of major diseases in India- communicable and non-communicable; Regional variation in Prevalence of diseases; sources of infection, modes of transmission and creation of Disease Network and the correlates; Spatial epidemiology; Disease Mapping; Geo-statistical methods of Health issues;

UNIT III

Structure of health care services in India; Health inequality; Problem of access and utilisation; Investment in Health; Public and Private Initiatives in health-care

provisions; Health policies and and programmes in Pre- and post- independent India; Non -governmental initiatives and case studies of these initiatives (Khanna, Matlab etc).

Suggested Readings:

1. B. K. Choudhary, 2008, Tuberculosis in India: A Political Ecology Approach, VDM Verlag.
2. P. Elliott, J. Wakefield, N. Best and D. Briggs, 2000, Spatial Epidemiology: Methods and Applications, Oxford University Press.
3. Paul Farmer, 1999, Infections and Inequalities: the Modern Plagues, Berkeley: University of California Press.
4. S. K. Lankinen, 1994, Health and Disease in Developing Countries, Macmillan Education Ltd, London and Oxford.
5. McMichael, A.J., Environmental and Social Influences on Emerging Infectious Diseases: Past, Present and Future, Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences, vol. 359, no. 1447, pp. 1049-1058. 2004.
6. M. S. Meade, R. J. Earickson, 2000, Medical Geography, 2nd Edition, The Guilford Press, London, UK.
7. J. Naidoo, J. Wills, 2001, Introduction To Health Studies, Pal Grave New York.
8. D. R. Phillips, Varhasset, Y., eds, 1994, Health and Development, Routledge, London.

GRPR-16: Field Survey and Analysis   Credits: 2

1. Introduction of research problems, objectives and research methodology.
2. Critical review of the thematic literatures.
3. Data collection and generation (indices, indicators); Field survey (sampling, design, representation, selection, overview); Analysis and interpretation of data and maps.

GRPR 17: **Research Proposal: Preparation and Presentation**   Credits: 2

Preparation of thematic appraisal of research proposal and its presentation (Seminar),
Preparation of synopsis (objectives; methodology and approaches, recent literature; hypotheses formulation, organisation of chapters and bibliography).

The research scholars have to undergo a Ph. D. course of 20 credits to be completed in two semesters. This course comprises three components (i) common course (3 credits), (ii) discipline specific course (7 credits) and (iii) research theme specific course (10 credits).

The research scholars of the Department will cover the **common course** through common lectures for all the students at faculty level. This common course has three compulsory papers of one credit each. The **discipline-specific course** (7credits) comprises of two compulsory courses of theory papers i.e. techniques in geological researches (4 credits) and computer application and instrumentation in Geology (3 credits). The **Research Theme-Specific Courses** of Department of Geology comprises 15 elective courses (Course code GLPR-01 to GLPR-15) of three credits each. Based on the research theme a research scholar shall choose any TWO elective courses (3x2=6 credit) as per suggestions of RPC and TWO compulsory courses (2x2=4 credits) to earn 10 credits.

OUTLINE

Course code	Title		Credits
Discipline-Specific Courses (7 Credits)			
GLPC-01	Techniques in Geological Research	Compulsory	4
GLPC-02	Computer Applications and Instrumentation in Geology	Compulsory	3
Research Theme-Specific Courses (10 Credits)			
GLPR-01	Advanced Structural Geology	Elective	3
GLPR-02	Mineralogy and Crystallography	Elective	3
GLPR-03	Igneous Petrology	Elective	3
GLPR-04	Tectonometamorphic Evolution	Elective	3
GLPR-05	Geomorphology and Remote Sensing	Elective	3
GLPR-06	Sedimentology	Elective	3
GLPR-07	Applied Palaeontology	Elective	3
GLPR-08	Advanced Indian Stratigraphy	Elective	3
GLPR-09	Coal Systems Analysis	Elective	3
GLPR-10	Ore System Study	Elective	3
GLPR-11	Hydrogeology	Elective	3
GLPR-12	Micropaleontology and Oceanography	Elective	3
GLPR-13	Petroleum System Elements	Elective	3
GLPR-14	Geochemistry	Elective	3
GLPR-15	Vertebrate Palaeontology	Elective	3
GLPR-16	Preparation and presentation of research plan proposal	Compulsory	2
GLPR-17	Review of literature and presentation of a seminar on a research-theme related topic	Compulsory	2

COURSE CONTENTS

GLPC-01: Techniques in Geological Research   Credits: 4

Concept of Plate Tectonics, physical and tectonics divisions of India. Stratigraphic Principles and classification; An over view of Geology of India; Geological mapping and Sampling in different types of terrains (e.g. structural, sedimentological, petrological, palaeontological and economic geology).

Different laboratory techniques. Advanced techniques in the study of minerals and rocks, identification, classification and interpretation of petrographic observations. GPS and its uses; Quaternary environments.

GLPC-02: Computer Applications and Instrumentation in Geology   Credits: 3

Computer application in geosciences, study of different softwares (MS-Excel, Power Point, Adobe Illustrator, CorelDraw and Photoshop).

Various sample preparation techniques in mineralogy; Historical development of X-ray crystallography and Bragg's equation, powder method in X-Ray crystallography; Electron probe micro analysis and scanning electron microscopy – principle, application and their utility in mineral sciences; Introduction to ion microprobe analysis and infra red spectroscopy; Introduction to mineral formulae calculation of important rock forming minerals.

RESEARCH THEME SPECIFIC COURSES

GLPR-01: Advanced Structural Geology   Credits: 3

Principles of rock mechanics; Types, representation and role of stresses in rock deformation; Dynamics of faulting under different stress regimes. Thin skinned tectonics. Strain ellipsoids, Strain analyses using strain markers in naturally deformed rocks; Shear zone indicators, dynamic analyses using shear zone structures. Penetrative and non penetrative fabrics and their use in structural analyses; Structural techniques for analyses of multiply deformed terrains; Mechanics of folding, fold interference patterns, Strain distribution in folds. Petrofabric analyses using Universal stage.

Suggested Readings:
1. Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Development. Pergamon Press.
2. Hobbs, B.E., Means, W.D. and Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons, New York.
3. Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill.
4. Ramsay, J.G. and Huber, M.I. (1983): Techniques of Modern Structural Geology, Vol. I, Strain Analysis, Academic Press.
5. Ramsay, J.G. and Huber, M.I. (1987): Techniques of Modern Structural Geology, Vol. II, Folds and Fractures, Academic Press.
6. Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III (Application of continuum mechanics), Academic Press.
7. Turner, F.J. and Weiss, L.E. (1963): Structural analysis of Metamorphic Tectonites, McGraw Hill.

GLPR-02: Mineralogy and Crystallography   Credits: 3

Fundamentals of crystal chemistry (Introduction to crystal chemistry, bonding in minerals, solid solution, polymorphism, isomorphism, pseudomorphism; Pauling's rules governing the ionic structures).

Silicates and their classification, A detailed study of important silicate mineral groups (Nesosilicates, Inosilicates, Phyllosilicates, Tektosilicates)

Historical development of crystallography and its importance in mineralogy; Introduction to 32 classes of symmetry, description of holosymmetric class of various crystal systems, international system of crystallographic notation; Different types of crystal projections – spherical and stereographic, and their uses; Symmetry of internal structures – Bravais lattices; Twinning and twin laws, common types of twins and their examples in minerals; Liquid crystals and their applications.

Suggested Readings:

1. Berry, L.G., Mason, B. and Dietrich, R.V. 1982, Mineralogy, CBS Publ.
2. Dana, E.S. and Ford, W.E. 2002, A textbook of Mineralogy (Reprint).
3. Kerr, P.F. 1977, Optical Mineralogy, McGraw Hill.
4. Moorhouse, W.W. 1951, Optical Mineralogy, Harper and row Publ.
5. Nesse, D.W. 198,: Optical Mineralogy, McGraw Hill.
6. Perkins, D. 1998, Mineralogy, Prentice Hall.
7. Winchell, E.N. 1951, Elements of Optical Mineralogy, Wiley Eastern.

GLPR-03: Igneous Petrology   Credits: 3

Nature and evolution of magma; Introduction to mantle petrology and mantle metasomatism, mantle heterogeneities; Plate tectonics and generation of magmas; Phase equilibrium - binary systems (Ab-An, Ab-Or, Di-An, Fo-Si) and their relations to magma genesis and crystallization in the light of modern experimental works.

Ternary systems (Di-Ab-An, Di-Fo-Si, Di-Fo-An, Ne-Ks-Si, Fo-An-Si) and their relations to magma genesis and crystallization in the light of modern experimental works; Interpretation of igneous textures in terms of rate of nucleation and crystal growth.

IUGS classification of the igneous rocks and CIPW norm; Petrology and petrogenesis of major igneous rock types with Indian examples of ultramafic, komatiite, basalt, granite, alkaline rocks, ophiolite, bornite, carbonatite, lamprophyre, lamproite, and kimberlite.

Plume magmatism and hot spots; Large igneous provinces and mafic dyke swarms; Partial melting (batch and fractional melting); Crystal fractionation (equilibrium and fractional (Rayleigh) crystallization); Contamination (AFC process) and dynamic melting.

Suggested Readings:
1. Bose, M.K. (1997): Igneous Petrology, World Press, Kolkata.
2. Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.
3. Cox, K.G., Bell, J.D. and Pankhurst, R.J. (1993): The Interpretation of Igneous Rocks, Champman and Hall, London.
4. Faure, G. (2001): Origin of Igneous Rocks, Springer.
5. Hall, A. (1997): Igneous Petrology, Longman.
6. LeMaitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambridge University Press.
7. McBirney (1994): Igneous Petrology, CBS Publ., Delhi.
8. Phillpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall of India.
9. Sood, M.K. (1982): Modern Igneous Petrology, Wiley-Interscience Publ., New York.

10. Srivastava, Rajesh K. and Chandra, R., (1995): Magmatism in Relation to Diverse Tectonic Settings, Balkema, Rotterdam.
11. Wilson, M. (1993): Igneous Petrogenesis, Chapman and Hall, London.
12. Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology, Prentice Hall, New Jersey.

GLPR-04: Tectonometamorphic Evolution   Credits: 3

Mineralogical phase rule for closed and open systems; Nature of metamorphic reactions; Metamorphic facies and facies series, UHT and UHP metamorphisms and their relationship with tectonic settings.

Detailed characteristic of different grades and facies of metamorphism.

Isograds and reaction isograds and their delineation in field; Schreinemakers rule and construction of petrogenetic grids with special reference to petrological problems; Metamorphic differentiation; Anatexis and origin of migmatites; Experimental work on anatexis; Regional metamorphism and paired metamorphic belts; Plate tectonics as a unifying theory of metamorphism and tectonics; P-T-t and P-T-t-d paths, their implications on tectonometamorphic evolution. Thermodynamics of metamorphic rocks; Geothermobarometry.

Suggested Readings:
1. Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., NewYork.
2. Bucher, K. and Martin, F. (2002): Petrogenesis of Metamorphic Rocks (7th Rev. Ed.), Springer–Verlag,.
3. Kerr, P.F. (1959): Optical Mineralogy, McGraw Hill Book Company Inc., New York.
4. Philpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall.
5. Powell, R. (1978): Equilibrium thermodynamics in Petrology: An Introduction, Harper and Row Publ., London.
6. Rastogy, R.P. and Mishra, R.R. (1993): An Introduction to Chemical Thermodynamics, Vikash Publishing House.
7. Spear, F. S. (1993): Mineralogical Phase Equilibria and pressure – temperature – time Paths, Mineralogical Society of America.
8. Spry, A. (1976): Metamorphic Textures, Pergamon Press.
9. Winter, J.D. (2001): An introduction to Igneous and Metamorphic Petrology, Prentice Hall.
10. Wood, B.J. and Fraser, D.G. (1976): Elementary Thermodynamics for Geologists, Oxford University Press, London.
11. Yardley, B.W.D., Mackenzie, W.S. and Guilford, C. (1995): Atlas of Metamorphic Rocks and their textures, Longman Scientific and Technical, England.
12. Yardlley, B.W.D. (1989): An introduction to Metamorphic Petrology, Longman Scientific and Technical, New York.

GLPR-05: Geomorphology and Remote Sensing   Credits: 3

Basic concepts and significance of geomorphology; Cycle of erosion, fluvial landforms and drainage patterns; Evolution of landforms in aeolian, marine, glacial and karst landscapes; An elementary idea about morphogenesis and morphography; Morphometric analysis, morphochronology; Neotectonics - geomorphological indicators, active faults, drainage changes, recurrent seismicity.

Geomorphology of India - Peninsular, Extra-peninsular and Indo-Gangetic plains; Application of geomorphology in mineral prospecting, civil engineering, military purposes, hydrogeology and environmental studies.

Electromagnetic radiation – characteristics, remote sensing regions and bands; General orbital and sensor characteristics of remote sensing satellites; Spectra of common natural objects – soil, rock, water and vegetation.

Aerial photos – types, scale, resolution, properties of aerial photos, stereoscopic parallax, relief displacement; Digital image processing - characteristics of remote sensing data, preprocessing, enhancements, classification; Elements of photo and imagery pattern and interpretation, application in Geology; Remote sensing applications in interpreting structure and tectonics; Lithological mapping, mineral resources, groundwater potentials and environmental monitoring.

Principles and components of GIS, remote sensing data integration with GIS, applications of GIS in various geological studies.

Suggested Readings:
1. Drury, S.A. (2001): Image Interpretation in Geology, Allen and Unwin.
2. Gupta, R.P. (1991): Remote Sensing Geology, Springer-Verlag.
3. Halis, J.R. (1983): Applied Geomorphology.
4. Holmes,A.(1992): Holmes Principles of Physical Geology, Edited by P. McL. D. Duff. Chapman and Hall.
5. Lillesand, T.M. and Kiefer, R.W. (1987): Remote Sensing and Image Interpretation, John Wiley.
6. Sharma, H.S. (1990): Indian Geomorphology, Concept Publishing Co., New Delhi.
7. Siegal, B.S. and Gillespie, A.R. (1980): Remote Sensing in Geology, John Wiley.
8. Thornbury, W.D. (1980): Principles of Geomorphology, Wiley Easton Ltd., New York.

GLPR-06: Sedimentology   Credits: 3

Texture - shape, size, fabric and surface textures, methods of textural analysis, textural parameters and their significance.

Petrogenesis of sandstones, graywacke and graywacke problem; plate - tectonics and sandstones composition; Argillaceous rocks, their classification and genesis.

Facies and facies analysis; Facies models of key continental sedimentary environments such as eolian, glacial and fluvial.

Fluid flow mechanics and formation of sedimentary bedforms; Facies models of coastal such as deltaic, esturerine, tidal flat, barrier and lagoon environments; Facies models of marine environments.

Suggested Readings:
1. Blatt, H., Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks, Prentice-Hall Inc.
2. Collins, J.D., and Thompson, D.B. (1982): Sedimentary Structures, George Allen and Unwin, London.
3. Lindholm, R.C. (1987) A Practical Approach to Sedimentology, Allen and Unwin, London.
4. Miall, A.D. (2000): Principles of Basin Analysis, Springer-Verlag.
5. Pettijohn;, F.J. (1975): Sedimentary Rocks (3rd Ed.), Harper and Row Publ., New Delhi.
6. Reading, H.G. (1997): Sedimentary Environments and facies, Blackwell Scientific Publication.
7. Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments, Springer-Verlag.
8. Selley, R. C. (2000) Applied Sedimentology, Academic Press.
9. Tucker, M.E. (1981): Sedimentary Petrology: An Introduction, Wiley and Sons, New York.

10. Tucker, M.E. (1990): Carbonate Sedimentology, Blackwell Scientific Publication.

GLPR-07: Applied Paleontology   Credits: 3

Application of palaeontology in organic evolution & palaeoenvironmental interpretations,
Modern thoughts on organic evolution; Coevolution of the Earth and its biota; Evolution of Primary Producers in the Sea; Macroevolution and mass extinction.

Modern systematics, ichnofossils, their modes of preservations and ichnofacies. Distribution, migration and dispersal of organisms; Approaches to palaeoecology; Taphonomy: principles and practices.

Suggested Readings:
   1. Boardman, R.S. Cheethan, A.M. & Rowell, A.J. (1988) Fossil Invertebrates (Blackwell)
   2. Clarksons, E.N.K. (1998) Invertebrate Palaeontology and Evolution
   3. Dobzhansky, Ayala, Stebbins & Valentine (1977) - Evolution (Freeman)
   4. Horowitz, A.S. & Potter, E.D. (1971) Introductory Petrography of Fossils (Springer Verlag)
   5. Mayr, E. (1971) Population, Species and Evolution (Harvard)
   6. Prothero, D.R. (1998) Bringing Fossil to Life – An Introduction to Palaeontology (McGraw Hill)
   7. Raup, D.M. and Stanley, S.M. (1985) Principles of Palaeontology (CBS Publications)
   8. Smith, A.B.(1994) Systematics & Fossil Record – Documenting Evolutionary Patterns (Blackwell)
   9. Strean, C.W. and Carroll, R.L. (1989) Palaeontology – the record of life (John Wiley)

GLPR-08: Advanced Indian Stratigraphy   Credits: 3

Introduction to Sequence-, magneto-, seismic-, chemo-, stratigraphy, Precambrian geochronology; Chronostratigraphy of the Precambrian of Singhbhum-Chotanagpur-Orissa Belt.

Introduction to important fossiliferous Phanerozoic sedimentary basins of India,

Precambrian / Cambrian boundary, Permian / Triassic boundary and Cretaceous / Tertiary boundary in India.

Suggested Readings:
   1. Danbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy. John Viley & Sons.
   2. Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India. Oxford UniversityPress
   3. Krishnan, M. S. (1982): Geology of India and Burma. C.B.S. Publishers & Distributors, Delhi
   4. Pascoe, E.H. (1968):A Manual of the Geology of India & Burma (Vols.I-IV) Govt. Of India Press, Delhi
   5. Pomerol, C. (1982) :The Cenozoic Era? Tertiary and Quaternary. Ellis Harwood Ltd., Halsted Press
   6. Schoch, Robert, M. (1989): Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York
   7. Doyle, P. & Bennett. M.R. (1996): Unlocking the Stratigraphic Record (John Villey)

GLPR-09: Coal Systems Analysis   Credits: 3

Definitions and geological controls of coal formation. Mode of occurrence of coal and types of seam discontinuities. Chemical methods of coal characterization. Types and techniques of coal sampling.

Coal Petrology – concept of 'lithotype', 'maceral' and 'microlithotype; Classification and optical properties of macerals and microlithotypes; Techniques and methods of coal microscopy; Elementary knowledge of the application of reflectance and fluorescence microscopy; Genetic interpretations of coal textures, particularly of Permian Coals of India. Applications of coal petrology.

Classification of coal in terms of rank, grade and type. Elementary idea about coal preparation. Application of coal petrology in coal carbonization, coal gasification, underground coal gasification (UCG), coal hydrogenation and coal combustion.

Coal Bed Methane (CBM) – An unconventional petroleum system; Generation of methane in coal beds; coal as a reservoir. Coal as a source rock for oil and gas. Geological and geographical distribution of coal and lignite deposits in India.

Suggested Readings:
1. Chandra, D., Singh, R.M. Singh, M.P. (2000): Textbook of Coal (Indian context), Tara Book Agency, Varanasi.
2. Scott, A.C. (1987): Coal and Coal-bearing strata: Recent Advances, Blackwell Scientific Publications.
3. Singh, M.P. (1998): Coal and organic Petrology,Hindustan Publishing Corporation, New Delhi.
4. Stach;, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, M. and Teichmuller R. (1982): Texbook of Coal petrology, Gebruder Borntraeger, Stuttgart.
5. Taylor,G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert P. (1998): Organic Petrology, Gebruder Borntraeger, Stuttgart.
6. Thomas, Larry (2002): Coal Geology, John Wiley and Sons Ltd., England.
7. Van Krevelen, D. W. (1993): Coal: Typology-Physics-Chemistry-Constitution), Elsevier Science, Netherlands.

GLPR-10: Ore Systems Studies   Credits: 3

Concept of ore bearing fluids, their origin and migration; Wall rock alteration; Geological controls of ore localization; Role of plate tectonics in ore deposits; Organic matters and its implication in ores; Fluid inclusions in ores - principles, assumptions, limitations and applications.

Studies of ore deposits associated with ultramafic-mafic rocks; felsic-silicic igneous rocks; Ores of sedimentary affiliation - biochemical, chemical and clastic sedimentation, placers and residual concentration deposits; Ores of metamorphic affiliations.

Ore microscopy: techniques, textures and microstructures of ores, interpretation of ore texture and optical properties of ore minerals; Application of ore microscopy.

Suggested Readings:
1. Branes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Willey.
2. Cuilbert, J.M. and Park,Jr. C.F.(1986): The Geology of Ore Deposits, Freidman.
3. Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
4. James R. Craig and David J.Vaughan (1994): Ore Microscopy and Petrography.
5. Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.
6. Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
7. Ramdhor, P. (1969): The Ore Minerals and their Intergowths, Pergamon Press.

8. Stanton, R.L. (1972): Ore Petrology, McGraw Hill.
9. Wolf, K.H. (1976-1981): Hand Book of Strata bound and Stratiform Ore Deposits, Elsevier Publ.

GLPR- 11: Hydrogeology   Credits: 3

Hydrological cycle with special reference to groundwater; Geological factors controlling groundwater occurrence and distribution; Aquifers and aquifer systems, geological formations as aquifers; Groundwater in different geological terrains of India; Bernoulli's equation and hydraulic head; Darcy's law and Reynolds number; Hydraulic conductivity, transmissivity, storage coefficient and specific capacity; Water table contour maps and flow net analysis.

Evaluation of hydrologic properties through pump tests and various methods for steadying and unsteady flow; Chemical characteristics of groundwater for various uses viz. domestic, industrial and irrigation; Prevention of saline water intrusion in coastal and other aquifers. Application of radioisotopes in hydro-geological studies; Groundwater contamination with special reference to arsenic, fluoride and nitrates.

Groundwater level fluctuations and environmental influences; Artificial recharging to groundwater and rainwater harvesting; Management of groundwater resources; Conjunctive use of groundwater and surface water; Groundwater problems. Effects of water in landslides; Environmental effects of over-exploitation of groundwater; Water logging problems; Groundwater legislation.

Suggested Readings:
1. C.F. Tolman (1937): Groundwater, McGraw Hill , New York and London.
2. D.K. Todd (1995): Groundwater Hydrology, John Wiley and Sons.
3. F.G. Driscoll (1988): Groundwater and Wells, UOP, Johnson Div.St.Paul. Min. USA.
4. H.M. Raghunath (1990): Groundwater, Wiley Eastern Ltd.,
5. H.S. Nagabhushaniah (2001): Groundwater in Hydrosphere (Groundwater hydrology), CBS Publ..
6. K. R. Karanth (1989): Hydrogeology, Tata McGraw Hill Publ..
7. S.N. Davies and R.J.N. De Wiest (1966): Hydrogeology, John Wiley and Sons, New York.

GLPR- 12: Micropaleontology and Oceanography   Credits: 3

Scope of subject; Modern field and laboratory techniques in the study of microfossils (collection, sampling and processing techniques, scanning electron microscopy and mass spectrometry).

Types of microfossils, Environmental significance of microfossils in general; Application of calcareous microfossils in reconstruction of history of past, environmental changes and biostratigraphic correlation; Micropaleontology in petroleum exploration; Geochemical study of microfossil tests (stable isotopes, radiocarbon isotopes and elemental composition) and its application in paleoceanography and paleoclimatology and tracing history of marine pollution; Interpretation of sea floor tectonism from micropaleontological evidence.

Ocean circulation, surface circulation; Concept of mixed layer, thermocline and pychnocline, Coriolis force and Ekman spiral, upwelling, Elnino, deep ocean circulation, concept of thermohaline circulation, formation of bottom waters, water masses of the world oceans, oceanic sediments.

Suggested Readings:
1. Alfred Traverse (1988): Paleopalynology, Unwin Hyman, USA.

2. Arnold (2002): Quaternary Environmental Micropaleontology (Ed. Simon K. Haslett), Oxford University Press, New York.
3. Bignot, G., Grahm and Trottman (1985): Elements of Micropaleontoogy, London.
4. David Tolmazin (1985): Elements of Dyanamic Oceanography, Allen and Unwin
5. Grant Gross, M. (1977): Oceanography; A view of the Earth, Prentice Hall.
6. John Houghton (1997): Global Warming, Cambridge Univ. Press.
7. Jones, T.P. and Rowe, T.P. (1999): Fossil plants and spores, Modern Techniques, Geological Soc. of London.

GLPR-13: Petroleum System Elements   Credits: 3

Carbon cycle; origin, composition and structure of organic matter; organic matter accumulation and formation of source rocks – kerogen. Organic maturation and thermal cracking of kerogen leading to the generation of hydrocarbons. Migration of petroleum. Reservoir rocks. Controls of petrology on the porosity and permeability of reservoir rocks. Reservoir traps – structural, stratigraphic and combination traps. Cap Rocks.

Identification and characterization (petrographic and geochemical) of petroleum source rocks. Kerogen types. Methods for the assessment of organic maturation. Methods and importance of Oil and source rock correlation. Locating petroleum prospects in a sedimentary basin using principles of petroleum generation and migration.

Oil belts of the world (Petroleum habitat). Onshore and offshore petroliferous basins of India.

Suggested Readings:
1. Barker, C. (1996): Thermal Modeling of Petroleum Generation, Elsevier Science, Netherlands.
2. Holson, G.D. and Tiratso, E.N. (1985): Introduction of Petroleum Geology, Fulf Publishing, Houston, Texas.
3. Hunt, J.M. (1996): Petroleum Geochemistry and Geology (2nd Ed.), Freeman, San Francisco.
4. Jahn, F., Cook, M. and Graham, M. (1998): Hydrocarbon exploration and production, Eslevier Science.
5. Makhous, M. (2000): The Formation of Hydrocarbon Deposits in North African Basins, Geological and Geochemical Conditions, Springer–Verlag.
6. North, F.K. (1985): Petroleum Geology, Allen Unwin.
7. Selley, R.C. (1998): Elements of Petroleum Geology, Academic Press.
8. Tissot, B.P. and Welte, D.H. (1984): Petroleum Formation and Occurrence, Springer–Verlag.

GLPR-14: Geochemistry   Credits: 3

Introduction and principles of geochemistry; Introduction, chemical composition and properties of atmosphere, hydrosphere and lithosphere; Geochemial cycles; Concepts of biogeochemical cycle; Geochemical classification of elements; Periodic table with special reference to transition and trace (including rare-earth) element geochemistry.

Stable isotope geochemistry of carbon and oxygen and its applications to geology; Radiogenic isotopes; Decay scheme of K-Ar, U-Pb and Rb–Sr and Sm-Nd; Petrogenetic implications of Sm-Nd, Rb-Sr; Radiometric dating of single minerals and whole rocks.

Element partitioning in mineral/rock formation and concept of distribution coefficient; Mineral stability in Eh-Ph diagrams; Sampling procedures and introduction to analytical techniques used in geochemistry; A brief introduction to geochemistry of natural waters and sedimentary rocks; Geochemical processes involved in rock weathering and soil formation; Principles of ionic substitution in minerals.

Crystal structure of some simple compounds – AX structures (NaCl, CsCl, ZnS, NiAs), AX_2 structure (fluorite, rutile); A brief idea about some other commpounds such as A_2X_3 (corrundum), ABX_3 (calcite, ilmenite) and AB_2X_4 (Spinel).

Suggested Readings:
1. Bloss, F.D. (1971): Crystallography and Crystal Chemistry, Holt, Rinehart, and Winston, New York.
2. Evans, R.C., (1964): Introduction to Crystal Chemistry, Cambridge Univ. Press.
3. Hoefs, J. (1980): Stable Isotope Geochemistry, Springer-Verlag.
4. Klein, C. and Hurlbut, C.S. (1993): Manual of Mineralogy, John Viley and Sons, New York.
5. Krauskopf, K.B. (1967): Introduction to Geochemistry, McGraw Hill.
6. Mason, B. and Moore, C.B. (1991): Introduction to Geochemistry, Wiley Eastern.
7. Rollinson, H.R. (1993): Using geochemical data: Evaluation, Presentation, Interpretation. Longman U.K.
8. Shikazono, N. (2003): Geochemical and Tectonic Evolution of Arc-Backarc Hydrothermal Systems - Implication for the Origin of Kuroko and Epithermal Vein-Type Mineralizations and the Global Geochemical Cycle, Eslevier Science.

GLPR-15: Vertebrate Paleontology   Credits: 3

Vertebrates: Origin and classification of vertebrates, general characteristics of vertebrates, vertebrate skeleton.
Fishes and Reptiles: Agnatha, origin of jaws, classification of fishes, mammal like reptiles, evolution and extinction of Dinasours; Aves – Archaeopteryx.
Mammals: Origin and classification of mammals, Siwalik mammals; Vertebrate life through ages; Evolutionary changes in Eqqus and homo.
Micro-vertebrates: Collection, maceration, picking and their identification, evolution, classification and tooth morphology of Rodents.

Suggested Readings:
1. Benton, M.J. (1990): Vertebrate Paleontology. Unwin Hyman, Lindon.
2. Colbert, E.H. (1984): Evolution of Vertebrates. Willey Eeastern Ltd.
3. Harris, J.M. and Leakey, M.G.(2003): Geology and Vertebrate Paleontology of Early Pliocene Site of Kanapoi, N. Kenya, Vol. 498, Natural History Museum, Lons Angeles.
4. Olson, E.G. (1971): Vertebrate Palaeozoology, Wiley, New York.
5. Romer, A.S. (1966): Vertebrate Paleontology (3rd Edn.) Chicago University Press.
6. Swnnerton, H.H. (1950): An outline of paleontology, Edward Arnold and Co.

GLPR-16: Preparation and presentation of research plan proposal   Credits: 2

GLPR-17: Review of literature and presentation of a seminar on a research theme related topic   Credits: 2

GEOPHYSICS

(Department of Geophysics)

Preamble

Every student admitted in the Department in the Ph. D. Programme shall be required to pass a Course Work of minimum of 20 credits. The 20 credit course work will normally be spread over two semesters.

There shall be THREE Compulsory Courses of 1 credit each, to be studied by all the research scholars registered in the Department. These courses will be taught at the Faculty level.

There shall be two Discipline-Specific Courses of 7 credits, compulsory to all the research scholars, irrespective of their field of research and stream at M.Sc. level. There shall be three Research Theme–Specific Courses. Out of which the research scholar shall have to opt any two Research Theme Specific courses (*of 4 credits each* out of course No. 1 to 22) as allotted by the concerned RPC, based on the deficiency of the research scholar in the particular specialization. The Research Theme Specific courses are: GPPR-01 to GPPR-06 for Exploration Geophysics, or Course GPPR-07 to GPPR-11 for Meteorology or Course GPPR-12 to GPPR-22 for Geophysics. In addition to these, the scholar shall have to clear the course GPPR-23, which is of 2 credits.

OUTLINE

Course Code	Name and Nature of Course	Credits
Discipline-Specific Courses		Credits: 7
GPPC-01A	Advanced Course in Applied Geophysics **or**	4
GPPC-01B	Advanced Course in Meteorology	
GPPC-02	Practical based on GPPC-01A/ GPPC-01B	3
** **Research Theme-Specific Courses**		Credits: 10
GPPR-01	Methods in Exploration Geophysics	4
GPPR-02	Elements of Geohydrology	4
GPPR-03	Seismology	4
GPPR-04	Geoelectrical Methods	4
GPPR-05	Gravity and Magnetic Methods	4
GPPR-06	Electromagnetic Methods	4
GPPR-07	Introductory Meteorology	4
GPPR-08	Advances in Agrometeorology	4
GPPR-09	Atmospheric Dynamics	4
GPPR-10	Physics of the Atmosphere	4
GPPR-11	Weather and Climate over Tropics	4
GPPR-12	O.O.P. through JAVA	4
GPPR-13	UNIX OS & Network Programming	4
GPPR-14	Structural Geology & Tectonics	4
GPPR-15	Environmental Geology & Natural Hazards	4
GPPR-16	Numerical Solution of Partial Differential Equations	4
GPPR-17	Fuzzy Sets and Applications	4
GPPR-18	Wavelets	4
GPPR-19	Engineering Hydrology	4
GPPR-20	Elements of Distribution Theory & Inference	4
GPPR-21	Advanced Statistical Techniques	4
GPPR-22	Elements of Sampling Theory	4
GPPR-23	Research Plan Proposal & Presentation /seminar	2

** Student can opt any **two** elective papers from GPPR-01 to GPPR-22.
   GPPR-23 is compulsory.

COURSE CONTENTS

GPPC-1A: Advanced Course in Applied Geophysics Credits: 4

Chemical composition of crust and upper mantle, oceanic and continental crust and its characteristics, Fluids and crustal earthquakes, stresses in the crust seismic hazards and risk analysis, site response for crustal studies and hazard analysis. Controlled Source Seismic (CSS) for investigation of the earth's crust.

Principle of magneto telluric technique, survey/field procedure and its application for mapping of sedimentary basin and deep crustal studies. Some modern techniques in electromagnetic (Time-domain and Frequency-domain) and induced polarization for mineral exploration.

Regional gravity and magnetic studies over continental and oceanic regions, crustal modeling, borehole gravity measurement and its applications, P velocity-density relation –ship and its importance, Applications of gravity and magnetic for delineation of basin structure, Exploration for mineral / oil / gas - a few case studies.

Deep electrical sounding for investigations of ground water at deeper depth and crustal structure, Multi-channel electrical resistivity imaging, Sustainable development of ground water resources and its management, recent techniques for aquifer parameterization.

Suggested Readings:
1. D.S. Parasnis, 1992. Current Science Special issue: Seismology in India and Overview: Mining Geophysics, John Wiley & Sons, NY.
2. H. P. Patra & K. Mallick, 1980, Geosounding Principles Vol. II, Elsevier, Amsterdam.
3. H.P. Patra, and S.K. Nath, 1999, Schlumberger Geoelectric Sounding in Ground Water(Principles, Interpretation and Application), Oxford & IBH Publication Co. Pvt. Ltd., New Delhi.
4. M.N. Nabighian (ED.), 1988, Electromagnetic Methods in Applied Geophysics, Vol- I & II, SEG, Tulsa, Oklahoma.
5. O. Koefoed, 1979, Geosounding Principe-I: Resistivity Sounding Measurements, Elsevier, Amsterdam
6. R.W. Day, 2002, Geotechnical Earthquake Engineering Handbook, McGraw, Hill.
7. S.L. Kramer, 1995, Geotechnical Earthquake Engineering, Printice Hall.
8. W.M. Telford, L.P. Geldart, R.E. Sheriff and D.A. Keys, 1990, Applied Geophysics, Cambridge University Press, London.

GPPC-01B: Advanced Course in Meteorology Credits: 4

Numerical weather prediction and related methods. Introduction of meso-scale models non-hydrostatic assumptions, basic structure of meso-scale models and their applications.

Synoptic systems in tropics and interpretation of charts, synoptic weather analysis, cloud picture analysis, synoptic techniques for weather prediction, understanding of Maden-Julian oscillation. Atmospheric pollutions and its distribution, climate systems and basic concepts of climate modeling, projection of climate change scenarios.

Energy balance and utilization by crops, Microclimate and crop growth, Water use efficiency and crop micro-weather modifications, Use of weather forecast in agriculture, Weather relationship of crops, Dynamic crop growth models and applications, Agro-climatic zones, Agricultural drought monitoring, Assessment and management.

Suggested Readings:
1. Compendium of Meteorology (Vol. I), 1981, Dynamic Meteorology, W.M.O. No. 364, Geneva.
2. G.C. Asnani, 2008, Tropical Meteorology, Noble Printers, Pune.

3. G.G. Tarakanov and M.G. Edelev, 1994, Tropical Meteorology, Mir Publication, Moscow.
4. G.J. Haltiner, and R.T. Willians, 1980, Numerical Prediction and Dynamic meteorology, John Wiley & Sons., New York.
5. J.R. Holton, 1979, An Introduction to Dynamic Meteorology, Academic Press., New York.
6. S. Venkatraman and A. Krishnan, 1992, Crops and Weather, Pub and Info Div, ICAR, New Delhi.

GPPC-02: Practical based on GPPC-01A/ GPPC-01B   Credits: 3

Practical details to be decided by the concerned teachers based on GPPC-01A/ GPPC-01B courses.

GPPR-01: Methods in Exploration Geophysics   Credits: 4

Physical properties of minerals and rocks.
Principles of geophysical exploration.
Gravity and Magnetic Methods: Stable and unstable gravimeters, Worden, Lacoste and Romberg, Hartley Askania and Gulf gravimeters, field procedure and reduction gravity data.
Fluxgate and Proton Precession magnetometers. Anomalies due to point pole and dipole, field practices and corrections.
Electrical and Electromagnetic Methods: Elements of SP, IP and resistivity methods, Wenner and Schlumberger configurations. Methods of resistivity profiling and sounding, theory of images, Tagg's method of interpretation.
Basic principles of electromagnetic and GPR methods
Seismic Method: Elementary principle of reflection and refraction methods, two layered reflection and refraction problems including inclined layer, fundamentals of conventional seismic instruments, fan shooting, profile shooting, continuous profiling and correlation methods of surveying.

Suggested Readings:
1. J.M. Reynolds, 1997, An Introduction to Applied and Environmental Geophysics, Jon Wiley & Sons, NY.
2. M.B. Dobrin & C.H. Savit, 1988, Introduction to Geophysical Prospecting, McGraw Hill, New York.
3. P.V. Sharma, 1986, Geophysical Methods in Geology, Elsevier, NY.
4. P.V. Sharma, 1997, Environmental and Engineering Geophysics, Cambridge University Press, London.
5. W.M. Telford, L.P. Geldart, R.E. Sheriff and D.A. Keys, 1990, Applied Geophysics, Cambridge University Press, London.

GPPR-02: Elements of Geohydrology   Credits: 4

Elements of Hydrological cycle
Hydrological Properties of Water Bearing Materials: Porosity, void radio, permeability, transmissivity, storativity, specific yield, specific retention, diffusivity, laboratory methods of determination of permeability.
Origin and Occurrence of Groundwater: Origin of groundwater, subsurface distribution of water, springs. Mode of occurrence of groundwater, classification of rock with respect to their water bearing characteristics, aquifers, aquicludes, aquitards, aquifuse, classification of aquifers and groundwater provinces.
Ground Water Flow: Darcy's law and its range of validity, theory of groundwater flow under steady and unsteady conditions, Movement of groundwater and aquifer performance tests, determination of permeability, transmissivity and storativity by discharging methods.

Surface Hydrology: Precipitation, evaporation, evapotranspiration, seepage, infiltration and runoff.

Hydro-geochemistry: Physical and Chemical characteristics of groundwater, classification of groundwater in respect to domestic, irrigation and industrial use, pollution of groundwater.

Water Resource Management: Natural and artificial recharge of groundwater, water balance, analysis of hydrograph, conjunctive and consumptive use of groundwater.

Suggested Readings:
1. D.K. Todd, 1980, Groundwater Hydrology, Wiley & Sons, Canada.
2. H.M. Raghunath, 2006, Hydrology: Principles, Analysis and Design, New Age International.
3. H.M. Raghunath, 2007, Ground Water, New Age International.
4. R. Ward, and M. Robinson, 1999, Principles of Hydrology, McGraw Hill, NY.
5. V.T. Chow, D.R. Maidmeni, and L.W. Mays, 1988, Applied Hydrology, McGraw Hill, New York.

GPPR-03: Seismology   Credits: 4

Introduction to earthquake phenomena: Concept of focus, focal depth, epicentre, great Indian earthquakes, intensity and magnitude scales and energy of earthquakes, foreshocks and aftershocks, elastic rebound theory.

Seismicity: Seismicity of India, Himalayas and global seismicity, seismic zonation, seismic micro-zonation, seismic zoning of India, induced seismicity, concept of inhomogeneity and anisotropy, types and causes of earthquakes.

Seismic Theory: Seismic ray theory for spherically stratified earth and velocity structure from travel time data, propagation and characteristics of body waves, surface waves, group and phase velocities, different phases of body waves and their applications, preparation of preliminary reports and identification of phases, determination of epicentre, focal depth and magnitudes, theory of elasticity, reflection of body waves, focal mechanism solutions and tectonic implications, earthquake generation models, hazard analysis, reflection of seismic waves from the free surface.

Monitoring of Seismic Phenomena: Principle of electromagnetic seismograph, displacement meters, velocity meter, accelerometer and strain meter seismographs, WWSSN stations, seismic arrays for detection of nuclear explosions, wideband seismometry, strong motion seismograph.

Suggested Readings:
1. J.G. Slawomir, and K. Andrezej, 1994, An Introduction to Mining Seismology, Academic Press, New York.
2. P.N. Agrawal, 1991, Engineering Seismology, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. S. Stein, and M. Wysession, 1991, An Introduction to Seismology, Earthquakes and Earth Structure, Wiley-Blackwell, Oxford.
4. T. Rikitake, 1976, Earthquake Prediction, Elsevier, Amsterdam.

GPPR-04: Geoelectrical Methods   Credits: 4

Electrical properties of rocks & minerals and their determinations

Basic Theory and Its Applications: Basics of direct current flow, relationship between point and line pole potential distribution, Quantities measured in various electrical resistivity method and description of the instruments used, discussion of various configurations used in electrical method and field procedure adopted.

D.C. Resistivity Methods: Potential distribution at the surface of horizontally stratified earth, Kernel function and its relation to the subsurface parameters, apparent resistivity function, computation of apparent resistivity model curves, principle of digital linear filtering.

Geoelectrical Sounding: Interpretation of resistivity VES data, empirical methods for interpretation of resistivity sounding data, indirect interpretation techniques, auxiliary point method, partial curve matching, complete curve matching, direct interpretation techniques, automatic direct interpretation method, Dar Zarrouk parameters, inversion techniques in resistivity method of interpretation, computer-aided resistivity data interpretation (softwares), principles of equivalence, suppression and delectability problems, effects of deviations from the fundamental assumptions, electrical resistivity imaging.

Geoelectrical Profiling: Profiling near a vertical contact and thin vertical dykes and discussion of the expected apparent resistivity curves.

Self Potential Method: Mechanism of SP field techniques, field due to vertically polarized sphere and interpretation.

Induced Polarized Method: Mechanism of IP instruments and principles of measurements both in time and frequency domain, interpretation of IP.

Miscellaneous Methods: Principles, application and interpretation of potential drop ratio method, equipotential lines method and telluric current methods.

Suggested Readings:
1. D.P. Ghosh, 1971, The Application of Linear Filter Theory to the Direct Interpretation of Geoelectrical Resistivity Measurements, Ph.D. Thesis, Delft University, The Netherlands.
2. G.V. Keller and F.C. Frischknecht, 1970, Electrical Methods in Geophysical Prospecting, Pergamon Press, New York.
3. H.P. Patra, and S.K. Nath, 1999, Schlumberger Geoelectric Sounding in Ground Water(Principles, Interpretation and Application), Oxford & IBH Publication Co. Pvt. Ltd., New Delhi.
4. O. Koefoed, 1979, Geosounding Principe-I: Resistivity Sounding Measurements, Elsevier, Amsterdam

GPPR-05: Gravity and Magnetic Methods   Credits: 4

Basic Theory: Magnetic elements I.G.R.F., inverse square law, concept of potential, Poisson's and Laplace's equations, magnetism on atomic scale, Dia- para- ferro magnetic materials, susceptibilities and densities of various rocks and minerals, factors affecting density and susceptibilities, and susceptibility determination.

Instrumentation: gravity prospecting instruments: borehole and airborne gravimeters, magnetic prospecting instruments, Rubidium vapour magnetometer.

Data Acquisition and Correction: Aeromagnetic surveys, plan of the field surveys, station spacing, corrections for gravity and magnetic data, calculation of derivatives, continuation methods, polynomial fitting for regional- residual separation of gravity and magnetic anomalies, filter theory and filtering of potential field data, Gravity anomalies over spheres, cylinders, dykes, faults and sheets, Magnetic anomalies over single pole, dipole, line pole, spheres, cylinders, faults and dykes, graticules and anomalies of irregular bodies, relation between gravity and magnetic potentials, depth estimation, curve matching techniques, transformation of gravity and magnetic anomalies in frequency domain, spectral representation of field data and interpretation of gravity and magnetic profiles.

Processing and interpretation: Gravity and magnetics for the exploration of the minerals, oil/gas and groundwater.

Suggested Readings:
1. I.V.R. Murthy, and D.C. Mishra, 1989, Interpretation of Gravity and Magnetic Anomalies in Space and Frequency Domains, AEG Publication, Hyderabad.
2. L.L. Nettleton, 1976, Gravity and Magnetics in Oil Prospecting, McGraw-Hill Book Co., New York.
3. M.B. Dobrin & C.H. Savit, 1988, Introduction to Geophysical Prospecting, McGraw Hill, New York.
4. W.M. Telford, L.P. Geldart, R.E. Sheriff and D.A. Keys, 1990, Applied Geophysics, Cambridge University Press, London.

GPPR-06: Electromagnetic Methods   Credits: 4

Basic Principles and Theory: Maxwell's equations, electromagnetic potential and wave equations, boundary conditions, long wavelength approximation, depth of penetration, electromagnetic field due to straight wire, rectangular and circular loops, elliptical polarizations, amplitude and phase relations, real (in phase) and imaginary (quadrature) components.

Methods of Prospecting: Bieler Watson method, Dip angle methods-fixed vertical loop transmitter, broadside and shoot back methods, two frame method, compensator method, Turam method, Moving source-receiver methods- horizontal loop (Slingram) method, AFMAG and VLF methods, Airborne EM systems- rotary field method, INPUT method, EM profiling and sounding.

Interpretation: Principles of EM similitude and modeling, response of conducting sphere to uniform alternating magnetic field and infinitely long horizontal cylinder to line source, response of sheet conductors to dip angle, Turam and horizontal loop EM systems, dip angle characteristic curves and phasor diagrams for horizontal loop EM system for sheets, effect of overburden on EM anomalies, Principles and practices of Ground Penetrating Radar.

Magnetotelluric (MT) method: Origin and characteristic of MT fields, MT instrumentation, field practices, MT effect over a conducting half space and two layer model.

Suggested Readings:
1. H.P. Patra & K. Mallick, 1980, Geosounding Principles Vol. II, Elsevier, Amsterdam.
2. M.N. Nabighian (ED.), 1988, Electromagnetic Methods in Applied Geophysics, Vol- I & II, SEG, Tulsa, Oklahoma.
3. M.S. Zhadnov and G.V. Keller, 1994, The Geoelectrical Methods in Geophysical Exploration, Elsevier, Amsterdam.
4. W.M. Telford, L.P. Geldart, R.E. Sheriff and D.A. Keys, 1990, Applied Geophysics, Cambridge University Press, London.

GPPR-07: Introductory Meteorology   Credits: 4

Composition and structure of the atmosphere
Thermodynamics: Thermodynamic principles, properties of dry and moist air, adiabatic processes, hydrostatic stability and instability, parcel method.
Radiation: Solar and terrestrial radiation, laws of radiation, green house effect, heat balance of the earth and its atmosphere.
Wind System: Geostrophic wind, gradient wind, thermal wind, cyclostrophic wind and inertial wind.
Air masses: front, jet stream. Extra tropical cyclones, tropical cyclones, anticyclones and western disturbances.
General circulation of the atmosphere: Northeast and southwest monsoon.
Principles of weather forecasting.

Suggested Readings:
1. F. K. Lutgens, E. J. Tarbuck and D. Tasa, 2006, The Atmosphere: An Introduction to Meteorology, Prentice Hall, New Jersey.
2. H. R. Byers, 1974, General Meteorology, McGraw-Hill, New York
3. J.M. Wallace and P.V. Hobbs, 1977, Atmospheric Science: An Introductory Survey, Academic Press. New York,
4. P. K. Das, 2005, The Monsoons, Nat Book Trust, New Delhi.
5. D. S. Lal. 1989, Climatology, Chaitanya Publishing House, Allahabad.

GPPR-08: Advances in Agrometeorology   Credits: 4

Long and Short term modifications, avoidable and unavoidable dangers in agrometeorology.

Solar Radiation and Plants, Spectral distribution of solar radiation and physiological response to plants, Light distribution in canopy, Phototropism and Photoperiodism: Meteorological factors in photosynthesis.

Effect of extreme ambient temperature, growing degree days and other heat indices, temperature coefficient (Q 10), soil temperature and factors affecting them, thermal properties of soil, Cardinal temperatures.

Soil moisture and its measurement, weekly water balance, water use and plant growth, evaporation and evapotranspiration.

Wind effect on evapotranspiration, wind damage to plants, transportation of pollen disease and insects by winds, wind profile near ground.

Climatic Requirements of Rice, wheat, cotton, soyabean and sugarcane, pearlmilet, groundnut and mustard.

Effect of weather on pathogenic agents- Insects, Fungi, Bacteria, Bacilli and Virus, combating plant diseases, natural and artificial methods, the integrated campaign, insect against insects, Bacteria and Bacilli against insect, Virus against Insects, effect of weather on the host.

Frost and frost fighting methods, hail damage and hail modification method, wind damage and wind breakers, Agricultural drought, its severity and management, flood, flood damage and flood fighting.

Soils composition, structure and physical properties, classification of soils, soil air, soil erosion.

Agrometeorological forecasts systems, short, medium and long range forecasts, yield forecasts model, system stimulation its concept, application and importance.

Suggested Readings:
1. B.V. Ramana Rao, 1988, Operational Agricultural Meteorology (Problems and Priorities), Ind Soc Agronomy, IARI, New Delhi.
2. H.S. Mavi, 1994, Introduction to Agrometeorology, Oxford & IBH, New Delhi.
3. J. Seemann, Y.I. Chirkov and J. Lomas, 1979, Agrometeorology, Springer-Verlag, Basel.
4. S. Venkatraman, 1992, Crops and Weather, Pub and Info Div, ICAR, New Delhi.
5. L.P. Smith, 1975, Methods in Agricultural Meteorology: Elsevier Publishing Co. Ltd., Amsterdam.

GPPR-09: Atmospheric Dynamics   Credits: 4

Laws of thermodynamics, internal energy, adiabatic process, specific heat capacity, enthalpy, entropy. Thermodynamics of water vapour and moist air. Isotherms on an , e diagram, equation of state of moist air, Clausius Clapeyron equation, adiabatic processes of saturated air and moisture variables.

Hydrostatic equation, geo-potential height computations for upper-air sounding, hydrostatic of homogeneous atmosphere, isothermal atmosphere, constant lapse rate atmosphere and dry adiabatic atmosphere. Properties of standard atmosphere.

Hydrostatic Stability and Instability: General consideration, slice method, entrainment. Fundamental forces, gravitation and gravity, geo-potential.

Equation of motion in different coordinate systems, tangential, local, rectangular coordinates, spherical polar coordinates, natural coordinates, scale analysis of the equations of motion, approximate equations, Rossby number. Continuity equation in cartesian, isobaric and spherical coordinate, Kinematics of vertical motion, Adiabatic and Omega equation.

Balanced Motion: Inertial wind, geostrophic wind, gradient wind, cyclostrophic wind and thermal wind.

Viscosity and Turbulence: Fundamental laws of viscosity, equations of mean motion in turbulent flow, mixing length theory, planetary boundary layer, power law, Ekman layer, Richardson number, Reynold's number, Froud number.

Circulation and Vorticity: Kelvin's circulation theorem, Bjerknes theorem, potential vorticity, vorticity equation, divergence equation, Helmholtz theorem.

Tendency equation, Bjenknes Holmboe theory, isallobaric wind.

Suggested Readings:
1. Compendium of Meteorology, Vol. I., 1981, Dynamic Meteorology, W.M.O. No. 364, Geneva.
2. G.J. Haltiner, and R.T. Willians, 1980, Numerical Prediction and Dynamic Meteorology, John Wiley & Sons., New York.
3. J. R. Holton, 1979, An Introduction to Dynamic Meteorology, Academic Press., New York.
4. S.L. Hess, 1979, Introduction to Theoretical Meteorology, Krieger Pub Co., New York.

GPPR-10: Physics of the Atmosphere   Credits: 4

Principle laws of radiation, geographical and seasonal distribution of solar radiation, direct beam insolation at the earth's surface, radiative heating and cooling, radiative equilibrium and the stratosphere, mean heat balance of the earth atmospheric system, poleward transport of energy, fundamental link with general circulation.

Atmospheric aerosols and condensation nuclei, nucleation, physics of initial stages of condensation, curvature and solution effect, growth and evaporation of cloud droplets by diffusion, the physics of precipitation in warm clouds, collision-coalescence theory, collection efficiency, terminal velocity, Bergeron and Findeisen's theory, artificial cloud seeding.

Mechanism of formation and destruction of atmospheric ozone, measurement of ozone, seasonal and latitudinal variation, Umkehr effect, vertical distribution of ozone, ozone-weather relationships, ozone hole.

Electrical field of the earth in fair and disturbed weather, atmospheric ionization, air-earth electric current and its maintenance, supply current, theories of charge generation and separation in thunderstorm, lightning discharges.

Orbital motion of satellites, types of meteorological satellites, visible and infra red data and their interpretation, identification of typical weather systems from cloud picture, estimation of winds, vertical temperature and humidity profile and rainfall from satellite observations, tropical cyclone grading using Dvorak's technique.

Suggested Readings:
1. D. S. Wilks, 2005, Statistical Methods in the Atmospheric Sciences, Academic Press., New York.
2. G. J. Haltiner, and R. T. Willians, 1980, Numerical Prediction and Dynamic Meteorology, John Wiley & Sons., New York.
3. H. von Storch and F. W. Zwiers, 2010, Statistical Analysis in Climate Research, Cambridge University Press., London.
4. M. Iqbal, 1983, An Introduction to Solar Radiation, Academic Press., New York.
5. S. Q. Kidder and T. H. Vonder Haar, 1995, Satellite Meteorology: An Introduction, Academic Press, , New York.

GPPR-11: Weather and Climate Over Tropics   Credits: 4

Meaning and scope of synoptic meteorology, Plotting of synoptic observations on different maps, analysis of surface and upper air charts. Primary, secondary and tertiary circulations. Kinematics of horizontal motion, characteristics of wind fields, construction of streamlines, isotach, trajectories, relation between stream line and trajectories, Blatons equation. Kinematics of pressure fields, mechanism and influence of pressure changes.

Jet streams, their classification and characteristics, PFJ, STJ, TEJ, low level jet stream of Asian monsoon, structure, formation, maintenance and associated weather, zonal index, index cycle, cutoff lows, highs, blocking.

Principle of Weather Prediction: Short range, medium range and long range weather prediction, limits of predictability, forecast evaluation.

Mean tropical atmosphere, equatorial trough (Inter Tropical Convergence Zone), basic currents, easterly waves and their dynamical aspects, formation and forecasting of easterly waves, Quasi Biennial Oscillation.

Tropical cyclones, classification of tropical disturbances, global climatology, life cycle, surface and upper air structure, thermal structure, the eye and wall cloud, rainfall, energy aspects, theories of formation, Conditional Instability of Second Kind, detection, movement tracks, re-curvature, Fujiwara effect, forecasting, storm surges, cyclone warning.

Monsoon regions in the tropics, causes of monsoon, Indian summer monsoon rainfall distribution, Elements of the monsoon system, Monsoon disturbances, inter-annual and intra-seasonal monsoon variability, Onset and advancement of monsoon, withdrawal, active, weak and break monsoon conditions, biweekly and 30-50 day oscillation (MJO), southern oscillation and El Nino, Indian ocean dipole, Tele-connections.

Winter seasons: western disturbances, cold waves, fog. Different convective phenomenon during pre-monsoon seasons: Nor'westers and tropical storms. Post monsoon season: Northeast monsoon.

Suggested Readings:
1. C.P. Chang and T.N. Krishnamurti, 1987, Monsoon Meteorology, Oxford Univ Press., London.
2. G.C. Asnani, 2008, Tropical Meteorology, Noble Printers, Pune.
3. G.G. Tarakanov and M.G. Edelev, 1994, Tropical Meteorology, Mir Publication. Moscow.
4. R.N. Keshavamurthy and M. Sankar Rao, 1992, The Physics of Monsoons, Allied Publ., New Delhi.
5. W.J. Saucier, 1989, Principles of Meteorological Analysis, Dover Publications, New York.

GPPR-12: Oop Through Java   Credits: 4

Object Oriented Analysis and Design concepts: Object modeling technique, General concepts, Object, Class, Data abstraction and Encapsulation, Inheritance, Polymorphism, Dynamic binding, Message passing; Benefits of OOP, Object – oriented languages. Object Oriented Programming using JAVA: Language basic – variables, Primitive data types, Operators Expressions, Statements and Blocks Control Flow Statements Arrays, Classes and Objects, Constructors and destructors, Operator Overloading, Type Conversions, Inheritance, Interfaces, Packages, Threads, Exception handling, Colors, Fonts and Graphics, Applets, Working with Input/ Output.

Suggested Readings:
1. Bruce Eckel, 2000, Thinking in JAVA, Pearson Education.
2. E. Balagurusamy, 2009, Programming with JAVA, Tata McGraw Hill.
3. Peter Van Der Linden, 2004, Just JAVA 2, Sun Micro Systems/ Prentice Hall.
4. Rodgers Cadenhead, Laura Lemay, 1999, Sams Teach Yourself JAVA 2 in 21 Days, Sams Publishing.

GPPR-13: UNIX OS & Network Programming   Credits: 4

General Overview, UNIX Kernel, Internal representation of files, buffering system calls, Process structure and Control, Process Scheduling, Memory Management, I/O Subsystem, Shell programming, IPC, Distributed UNIX systems.

The UNIX model, inter-process communication, communication protocols, Berkeley sockets, Transport Layer Interface, Library and other Routines, Security issues, FTP, Line Printer Spoolers, Remote Login, Remote Execution, Remote Procedure Calls, Remote Drive Access.

Suggested Readings:
1. B.W. Kernighan and R. Pike, 1996, The UNIX Programming Environment, PHI.
2. Barry Nance, 1990, Network Programming in C, PHI.
3. M.J. Bach, 1996, The design of UNIX Operating System, PHI.
4. R. Thomas and J. Yates, 1982, A User Guide to the UNIX system, Osborne McGraw Hill.
5. W.R. Stevens, 1997, UNIX Network Programming, PHI.

GPPR-14: Structural Geology & Tectonics   Credits: 4

Mechanical principles, properties of rocks and their controlling factors; Concept of stress; Theories of rock failure; Two-dimensional stress analyses; Causes and dynamics of faulting, strike-slip faults, normal faults, thrust faults; Thin-skinned deformation; Decollement.
Concept of strain, two dimensional strain analysis; Types of strain ellipses and ellipsoids, their properties and geological significance; Methods of strain measurements in naturally deformed rocks; Mechanics of folding and buckling, superposed folding patterns, fold development and distribution of strains in folds.
Brittle and ductile shear zones, geometry and products of shear zones; Mylonites and cataclasites; Planar and linear fabrics in deformed rocks, their origin and significance.
Basic idea about petrofabrics and use of universal stage; Stereographic and equal area projections for representing different types of fabrics, π and β diagrams; Geometrical analysis of simple and complex structures on macroscopic scale.
Paleomagnetism, polar wandering and reversal of earth's magnetic field; Geomagnetic time scale; Concept of plate tectonics, nature and types of plate margins, geometry and mechanism of plate motion; Island arcs and mountain chains, their global distribution and evolution; Orogenic and epeirogenic phases; Plate tectonic evolution of India.

Suggested Readings:
1. C. Condie Kent, 1982, Plate Tectonics and Crustal Evolution, Pergamon Press Inc.
2. J.G. Ramsay and M.I. Huber, 1983, Techniques of Modern Structural Geology, Vol. I, Strain Analysis, Academic Press.
3. J.G. Ramsay and M.I. Huber, 1987, Techniques of Modern Structural Geology, Vol. II, Folds and Fractures, Academic Press.
4. J.G. Ramsay and M.I. Huber, 2000, Techniques of Modern Structural Geology, Vol. III (Application of continuum mechanics), Academic Press.
5. S.K. Ghosh, 1993, Structural Geology: Fundamental and Modern Developments. Pergamon Press.

GPPR-15: Environmental Geology & Natural Hazards   Credits: 4

Components of environmental geology; Time scales of global changes in the ecosystem and climate; Major icehouse and greenhouse periods; Impact of oceanic and atmospheric circulation on climate and rain fall;
Methodologies for estimation of present and past atmospheric carbon-dioxides; CO_2 increase and global warming in the present and past atmospheres.
Physical, chemical and biological domains of environment; Air, water and noise pollution, their causes and remedial measures; Surface weathering, development of soil and soil pollution; Pollution in the mining areas.
Distribution, magnitude and intensity of earthquakes; Seismic hazard zones; Neotectonics in seismic hazard assessment; Landslide, floods and volcanic hazards their causes and control; Coastal erosion, its causes and control.

Problems of urbanization, human population and their impact on environment; Alternative sources of energy; Waste disposal and related problems; Environmental legislations.

Suggested Readings:
1. A.M. Patwardhan, 1999, The Dynamic Earth System, Prentice Hall.
2. D. S. Lal, 2007, Climatology, Sharda Pustak Bhawan, Allahabad.
3. F.G. Bell, 1999, Geological Hazards, Routledge, London.
4. K. Smith, 1992, Environmental Hazards, Routledge, London.
5. V. Subramaniam, 2001, Textbook in Environmental Science, Narosa International.

GPPR-16: Numerical Solution of Partial Differential Equations   Credits: 4

Numerical solutions of parabolic PDE in one space: two and three levels explicit and implicit difference schemes. Convergence and stability analysis.
Numerical solution of parabolic PDE of second order in two space dimension: implicit methods, alternating direction implicit (ADI) methods. Non linear initial BVP.
Difference schemes for parabolic PDE in spherical and cylindrical coordinate systems in one dimension.
Numerical solution of hyperbolic PDE in one and two space dimension: explicit and implicit schemes. ADI methods. Difference schemes for first order equations.
Numerical solutions of elliptic equations, approximations of Laplace and biharmonic operators. Solutions of Dirichlet, Neuman and mixed type problems.
Finite element method: Linear, triangular elements and rectangular elements.
Practicals based on the above contents.

Suggested Readings:
1. C. F. General and P. O. Wheatley, 1998, *Applied Numerical Analysis*, Addison-Wesley.
2. D. V. Griffiths and I. M. Smith, 1993, *Numerical Methods of Engineers*, Oxford University Press.
3. M. K. Jain, 1994, *Numerical Solution of Differential Equations*, 2nd edition, Wiley Eastern.
4. M. K. Jain, S. R. K. Iyenger and R. K. Jain, 1994, *Computational Methods for Partial Differential Equations*, Wiley Eastern.
5. S. S. Sastry, 2002, *Introductory Methods of Numerical Analysis*, Prentice-Hall of India.

GPPR-17: Fuzzy Sets and Applications   Credits: 4

Basic Concepts of Fuzzy Sets and Fuzzy Logic: Motivation. Fuzzy sets and their representations. Membership functions and their designing. Types of Fuzzy sets.Operations on fuzzy sets. Convex fuzzy sets. Alpha-level cuts. Geometric interpretation of fuzzy sets. Linguistic variables. Possibility measure and distribution. Fuzzy rules. Fuzzy Relations and Fuzzy Arithmetic: Composition of fuzzy relations. Fuzzy numbers. Arithmetic operations on fuzzy numbers.
Fuzzy reasoning: Fuzzy mapping rules and fuzzy implication rules. Fuzzy rule-based models for function approximation. Types of fuzzy rule-based models (the Mamdani, TSK, and standard additive models). Fuzzy Implications and Approximate Reasoning:
Fuzzy Logic and Probability Theory :Possibility versus probability. Probability of a fuzzy event. Baye's theorem for fuzzy events. Probabilistic interpretation of fuzzy sets. Fuzzy measure.
Decision making in Fuzzy environment: Fuzzy Decisions, Fuzzy Linear programming, Fuzzy Multi criteria analysis, Multiobjective decision making.
Fuzzy databases and queries: Introduction, Fuzzy relational databases, Fuzzy queries in crisp databases.

Suggested Readings:
1. G. J. Klir and B. Yuan, 1997, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice-Hall of India.
2. H.J. Zimmermann, 2001, Fuzzy Set Theory and Its Applications, Kluwer Academic Publ.
3. J. Yen and R. Langari, 2003, Fuzzy Logic: Intelligence, Control, and Information, Pearson Education.

GPPR-18: Wavelets
Credits: 4

Fourier Analysis: Fourier and inverse Fourier transforms, Convolution and delta function, Fourier transform of Square integrable functions. Fourier series, Basic Convergence Theory and Poisson's Summation formula.
Wavelet Transforms and Time Frequency Analysis: The Gabor Transform. Short-time Fourier transforms and the uncertainity principle. The integral wavelet transforms Dyadic wavelets and inversions. Frames. Wavelet Series.
Scaling Functions and Wavelets: Multi resolution analysis, scaling functions with finite two scale relations. Direct sum decomposition of $L^2(R)$. Linear phase filtering, Compactly supported wavelets, Wavelets and their duals, Orthogonal Wavelets and Wavelet packets, Example of orthogonal Wavelets. Identification of orthogonal two-scale symbols, Construction of Compactly supported orthogonal wavelets, Orthogonal wavelet packets, orthogonal decomposition of wavelet series.

Suggested Readings:
1. C.K.Chui, 1996, A First Course in Wavelets, Academic press, NY.
2. I. Daubechies, 1992, Ten Lectures in Wavelets, Society for Industrial and Applied Maths.

GPPR-19: Engineering Hydrology
Credits: 4

Fick's laws of Diffusion; Advection – diffusion equation (ADE) in different coordinate systems. Its application: solute transport in air, soil and water. Cells migration. Initial and boundary value problems.
Different methods to solve ADE: Integral transforms; Aris moment method; Purturbation method; Super imposition method; Generalized integral Laplace transformation technique supported by matrix-diagonalization; Advection diffusion multilayer method; Finite difference methods.
Inverse dispersion problems; the point dilution theory; determination of diffusion coefficient on isotropic diffusion operator with constant coefficients and variable coefficients; isotropic and anisotropic diffusion operator.
Ground water flow; Darcy law, generalized Darcy law; Equations of confined and unconfined ground water flow; steady flow into a well; unsteady flow in a confined aquifer.
Forms of sub – surface water; aquifer properties; compressibility of aquifers.
Ground water pollution; origins and physical characteristics; technical studies of ground water pollution; canonical rectangular bi-dimensional monolayer and multilayer models of pollution.

Suggested Readings:
1. D.K. Todd, 2004, Ground Water Hydrology, John Wiley & Sons
2. E. M. Wilson, 1990, Engineering Hydrology, MacMillan
3. K. Subramanya, 2006, Engineering Hydrology, TMH.
4. J.J. Fried, 1990, Ground Water Pollution (Theory, Methodology, Modeling, Practical Rules), Elsevier,

GPPR-20: Elements of Distribution Theory & Inference   Credits: 4

Advanced Distribution Theory: Functions of random variables and their distributions using Jacobian of transformation and other tools. Distributions of the sum of finite number of random variables. Concept of derived distributions of a function of random variables. Sampling distributions of sum of binomial and Poisson distributions. Convolution and compound distributions. Truncated and mixture distributions.
Review of Standard univariate discrete and continuous distributions. Their properties and applications in real world problems.
Elements of Statistical Inference: Review of statistical inference problems. Standard point estimation. Procedures for regular and non – regular families. Theory of confidence sets with examples from bivariate and multivariate distributions. Neyman – Pearson's concept in testing of hypothesis. Generalized N – P lemma. Testing of composite hypothesis. Sequential inferential procedures. An over – view of non – parametric and semi – parametric inferential procedures.

Suggested Readings:
1. B.K. Kale, 1999, A First Course on Parametric Inference, Narosa Publishing House, New Delhi.
2. E.L. Lehman, and J. P. Romano, 2005. Testing Statistical Hypothesis, Third Edition, Springer.
3. R.G. Laha and V.K. Rohatgi, 1979, Probability Theory, Wiley, Princeton University.

GPPR-21: Advanced Statistical Techniques   Credits: 4

Elements of Stochastic Processes: Poisson distribution and Poisson process. Interarrival time distribution in Poisson process. Constant hazard rate and exponential distribution. Time dependent Poisson process. Birth process. Death process. Birth - death process. Birth – death – immigration process. Random walk models. Gambler's ruin problem.
Topics On Research Methodology: Definition and type of research. Steps in research process: Conceptual phase, empirical phase, analytical phase. Measurements. Report writing.
Topics On Multivariate Analysis: Factor analysis : Linear factor models. Estimation of factor loadings. Factor rotation. Estimation of factor scores. Testing goodness of fit. Cluster analysis.
Statistical Computing: Use of computers and standard softwares like, SPSS, SAS, STATA, SYSTAT. Writing FORTRAN / C programmes for solving the problems related to the topics of CORE PAPERS – I and II.

Suggested Readings:
1. B.W. Kernighan, and D.M. Ritchie, 1988, The C Programming Language, Second Edition, Prentice Hall, New Jersey.
2. C.R. Kothari, 1985, Research Methodology: Methods and Techniques, Wiley Eastern, New Delhi.
3. R.A. Thisted (1988): Elements of Statistical Computing, Chapman and Hall, New York.
4. R.L. Dominowski, 1980, Research Methods, Prentice Hall Inc., New Jersey.
5. R.P. Mishra, 1980, Research Methodology, Handbook Concept Publishing Company, New Delhi.
6. S.M. Ross, 1983, Stochastic Processes, Wiley & Sons, New York.

GPPR-22: Elements of Sampling Theory   Credits: 4

Basic concepts in sampling: population, sample, sampling design, sampling frame, target and frame populations, Need and importance of probability sampling.

Planning of large scale sample surveys: Operations and associated errors, Acquaintance with the working (questionnaire, sampling design, methods followed in field investigation, principal findings, etc.) of NSSO and other agencies undertaking sample surveys, Concept of design effect.

Issues in Stratified Random Sampling: allocation problems involving several auxiliary variables; re-weighting by strata sizes; two – way stratification and its comparison with one – way stratification; stratum boundary determination problems.

Probability proportional to size sampling: πps and pps sampling; Horvitz – Thompson's estimator (THE); variance of THE, its estimation and related issues; IPPS schemes of sampling due to Midzuno – Sen, Brewer, Durbin and JNK Rao (sample size 2 only), Rao-Hartley-Cochran sampling scheme for sample size n with random grouping.

Two – stage sampling with unequal number of second stage units; stratified multi – stage sampling

Multi – phase sampling for ratio, regression, pps estimation and for stratification.

Certain important classes of estimators with and without auxiliary information, Jackknife technique, bootstrap technique.

Repetitive surveys: minimum variance current estimates; estimation of change; optimum replacement policy; regression estimation in repetitive surveys.

Suggested Readings:
1. A. Chaudhari, and J.W.E. Vos, 1988, Unified Theory and Strategies of Sampling, North Holland, Amsterdam.
2. C.E. Sarndal, B. Swensson, and J. Wretman, 1992, Model Assisted Survey Sampling, Springer – Verlag, Basel.
3. D. Raj, and P. Chandhok, 1999, Sample Survey Theory, Narosa Publishing House, New Delhi.
4. P. Mukhopadhyay, 2000, Theory and Methods of Survey Sampling, Prentice Hall of India, New Delhi.
5. P.V. Sukhatme, B.V. Sukhatme, S. Sukhatme, and C. Asok, 1984, Sampling Theory of Surveys with Applications, Iowa State University Press, Iowa.
6. S. Singh, 2003, Advanced Sampling Theory with Applications: How Michael "Selected" Amy, Kluwer Academic Publishers, The Netherlands.

GPPR-23: Research Plan Proposal & Presentation   Credits: 2

The research scholar has to prepare a Research Plan Proposal based on the theme of his/her research work; and present the same before the concerned RPC and DRC of the Department. The evaluation shall be done by the concerned RPC of the research scholar.

Home Science

(Department of Home Science)

Preamble

The Research scholars of Home Science department have to undergo a Ph.D. course work of minimum 20 credits. The evaluation of the candidates will be as per the ordinances of "course work" for Ph.D. programs in the Faculty of Science. The course work comprises of three components, the **Faculty Level Common Course** (**3 Credits**), **Discipline-Specific Courses** (**7 Credits**) and **Research Theme-Specific Courses** (**10 Credits**). The Discipline Specific Courses comprise of two compulsory theory papers (**HSPR-01** & **HSPR-02**) while research scholars select their subject as per their specialization from **Group A to Group E**. The details of course work are given below:

OUTLINE

Discipline-Specific Course (7 Credits)		
Course Code	**Name of Course**	**Credits**
HSPC-01	Technical Writing and Communication Skills	1
HSPC-02	Gender Sensitization for Empowerment	2
HSPC-03	Preparation of Scale and its Standardization	3
HSPC-04	*Practicals based on course* HSPC-01	1
Research Theme-Specific Courses:- 10 Credits Courses (including compulsory Seminar)		
HSPR-01	Preparation of Research Plan Proposal (write up) & Presentation and defence	2 (Compulsory)
HSPR-02	Review of Literature and Presentation of a seminar on a research-theme related topic duly approved by the concerned RPC	2 (Compulsory)
Each research scholar will select 6 Credit courses from the list of Research theme-specific courses, given below, as advised by R.P.C.		
Group – A:- Food and Nutrition		
HSPR-03	Food Processing Technology	3
HSPR-04	Food Analysis	2
HSPR-05	Food Product Development	2
HSPR-06	Nutrition and Agriculture Interface	3
HSPR-07	*Practicals based on course* HSPR-04	1
HSPR-08	*Practicals based on course* HSPR-05	1
Group – B:- Extension and Communication		
HSPR-09	Global Extension Systems	4
HSPR-10	Educational Technology	2
HSPR-11	Visual communication	2
HSPR-12	*Practicals based on course* HSPR-10	2
HSPR-13	*Practicals based on course* HSPR-11	2
Group – C:- Human Development		
HSPR-14	Children with Developmental Challenges	2
HSPR-15	Advances in Family Studies	2
HSPR-16	Trends and Issues in Human Development	2

HSPR-17	Parent and Community Education	1
HSPR-18	Gender issues in Human Development and Family Relations	2
HSPR-19	Advances in Life Span Development	1
HSPR-20	*Practicals based on course* HSPR-14	1
HSPR-21	*Practicals based on course* HSPR-15	1
HSPR-22	*Practicals based on course* HSPR-17	2
HSPR-23	*Practicals based on course* HSPR-18	1
HSPR-24	*Practicals based on course* HSPR-19	1
Group – D:- Clothing and Textiles		
HSPR-25	Technical Textiles	2
HSPR-26	Eco-Textile	3
HSPR-27	Non-Woven Textile	3
HSPR-28	Apparel Quality analysis	2
HSPR-29	*Practicals based on course* HSPR-25	1
HSPR-30	*Practicals based on course* HSPR-28	1
Group – E:- Family Resource Management		
HSPR-31	Globalization and Consumer Economics	2
HSPR-32	Advanced Housing	2
HSPR-33	Managerial Dimensions for special Groups	2
HSPR-34	*Practicals based on course* HSPR-31	2
HSPR-35	*Practicals based on course* HSPR-29	2
HSPR-36	*Practicals based on course* HSPR-30	2
Note: After the enrolment in Ph.D. programme students registered in affiliated colleges will opt for subjects in their respective colleges only.		

COURSE CONTENTS

HSPC-01: Technical Writing And Communication Skills   Credit: 1

Scientific writing as a means of communication: Different forms of scientific writing Articles in journals. Research notes and reports. Review articles, Monographs, Dissertations, Bibliographies.
Writing for Grants: Clearly state the question to be addressed**,** Rationale and importance of the question being address**,** Emperial and theoretical conceptualization**,** Presenting pilot study/data**,** Research proposal and time frame**,** Clarity, specificity of method**,** Clear organization**,** Outcome of study and its implications**,** Budgeting**,** Available infra-structure and resources**,** Executive summary

HSPC-04: Practical Based on Course HSPC-01   Credit: 1

A. **Technical Writing** - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.
B. **Communication Skills** - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings:
1. Chicago Manual of Style. 14th Ed. 1996, Prentice Hall of India.
2. Collins' Cobuild English Dictionary. 1995, Harper Collins.
3. Gordon HM & Walter JA. 1970, Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
4. Hornby AS. 2000, Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
5. James HS. 1994, Handbook for Technical Writing. NTC Business Books.
6. Joseph G. 2000, MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
7. Mohan K. 2005, Speaking English Effectively. MacMillan India.
8. Richard WS. 1969, Technical Writing. Barnes & Noble.
9. Robert C. (Ed.). 2005, Spoken English: Flourish Your Language. Abhishek.
10. Sethi J & Dhamija PV. 2004, Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
11. Wren PC & Martin H. 2006, High School English Grammar and Composition. S. Chand & Co.

HSPC-02: Gender Sensitization for Empowerment   Credits: 2

Gender and empowerment: meaning, gender related definitions and importance for empowering women; need and focus on gender sensitization- gender in community diversity and its implication for empowerment. Gender perspectives in development of women, social characteristics, roles, responsibilities, resources, constraints, legal issues and opportunities; economical, educational and other parameters. Gender tools and methodologies: Dimensions and methodologies for empowerment; gender budgeting; gender analysis framework- context, activities, resources and programme action profile; technologies and empowerment - gender specific technologies, household technology interface, socio-cultural interface and women as consumer of technologies. Gender issues and development: health and nutrition, violence, governance, education and media.

Suggested Readings:
1. Cockburn C & Ormrod S. 1993, Gender and Technology in the Making. Sage Publ.
2. Grover I. 2006, Introducing Gender. Manual, Department of Home Science Extension Education, COHS, CCS HAU, Hisar.
3. Grover I. 2006, Unpacking Gender and Feminism. Manual, Department of Home Science Extension Education, COHS, CCS HAU, Hisar.
4. Grover I., Kaushik S & Khetarpaul N. 2006, Gender Health and Nutrition. Manual, Department of Home Science Extension Education, COHS, CCS HAU, Hisar.
5. Kaushik S. 2006, Gender & Education. Manual, Department of Home Science Extension Education, COHS, CCS HAU, Hisar.
6. Krishanraj M & Chanani K. 1989, Gender and the Household Domain -Social and Cultural Dimension. Sage Publ.
7. Me Neil Maureen (Ed.). 1989, Gender and Expertise. Free Association Books.
8. Mehta S. 2006, Gender and Media. Manual, Department of Home Science Extension Education, COHS, CCS HAU, Hisar.
9. Oxfam 1994, Gender Training Manual. Oxfam.
10. Rani S. 2006, Gender and Work. Manual, Department of Home Science Extension Education, COHS, CCS HAU, Hisar.
11. Rose K. 1992, Where Women are Leaders -The SEWA Movement in India. Vistaar Publ.
12. Shiva V. 1989, Staying Alive - Women, Ecology and Development. Zed Books.
13. Yadav L. 2006, Gender and Governance. Manual, Department of Home Science Extension Education, COHS, CCS HAU, Hisar.

HSPC-03: Preparation of Scale and its Standardization   Credits: 3

- Interview Schedule and questionnaire-concept, and construction
- Scale and Scaling technique-meaning, types, principles, steps and quality. Various types of attitude measurement-paired comparison, equal opening rating scale, scale gram analysis and scale dissemination technique
- Pre-testing and Pilot study
- Reliability – validity techniques

Suggested Readings:
1. APA 1984, Publication Manual of American Psychological Association (3rd Edition), Washington, APA
2. Extension Education in Community Development 1981, Ministry of Food and Agriculture, Government of India, New Delhi.
3. Locke, L.F. and Others 1987, Proposals that work: A Guide for Planning Dissertations & Grant proposals (2nd Ed.), Beverly Hills: Sage.
4. Mullins, C.J. 1977, A Guide to Writing and Publishing in Social and Behavioral Sciences, New York: John Wiley & Sons.
5. Pankajam, G. 2000, Extension – Third Dimension of Education, Gyan Publishing House, New Delhi.
6. Reddy, A. 1999, Extension Education, Sree Lakshmi Pres, Bapatla.
7. Stemberg, R.J. 1991, The Psychologist's Companion: A Guide to Scientific Writing for Students and Researchers, Cambridge, OUP.
8. Waghmare, S.K. 1989, Exploring of Extension Excellence, Multi Tech. Pub. Company.

RESEARCH THEME-SPECIFIC COURSES

Group- A- FOOD AND NUTRITION

HSPR-03: Food Processing Technology   Credits: 3

Principles underlying food processing operations including thermal, radiation, refrigeration, freezing and dehydration. Effect of processing on physicochemical characteristics.
Processing technology for preservation and production of variety food products, losses during storage, handling and processing of cereals and legumes, oilseeds, fruits and vegetables.
Processing technology for milk and milk products, egg, meat, poultry and fish, convenience foods, processed foods. Technologies underlying in mutual supplementation, enrichment and fortification, fermentation, malting, germination. Food additives commonly used in food industries for color, flavor, and as preservatives. Quality control in food industry: raw material , finished products. Waste management and sanitation in food industries. Packaging of foods. Storage and marketing of processed foods.

Suggested Readings:
1. P J Fellows, Food processing technology: Principles and practice (Third edition) Consultant, UK Woodhead Food Series No. 174 June 2009, Woodhead Publishing Limited.
2. Da-Wen Sun, Emerging Technologies For Food Processing, National University of Ireland, Earlsfort Terrace, Dublin Hardbound, 792 pages, publication date: JUL-2005.
3. R.Y. Yada, Rickey Yoshio Yada, Proteins in food processing, CRC Press, 2004.
4. Peter Fellows, Food processing technology: principles and practice, CRC Press, 2000.

HSPR-04: Food Analysis   Credits: 2

Familiarization to terms and calculations used in preparation of various standard solutions. Sample and sampling techniques. Principles, techniques and applications of colorimetric, spectrophotometer and atomic absorption spectrophotometer. Principles, techniques and applications of spectrophotometer fluirimetry, flame photometry and electrophoresis.
Principles techniques and application of chromatography (paper chromatography, TLC,GLC, HPLC). Introduction to animal assay.

HSPR-05: Food Product Development   Credits: 2

Basic principles of food product development. Sensory properties of food and their role in product development. Formulation and evaluation of recipes at laboratory level. Bulk food preparation for food institutions and enterprises: servings, nutritive value and costing.
Evaluation of food- Objective and subjective methods, selection and training of judges, development of score cards and analysis of data. Consumer evaluation-development of schedule and data analysis. Packaging material, types for different products. Food labeling. Food safety issues in product development, food quality regulations and standards, quality control and HACCP. Product formulation and development for general and therapeutic use.

HSPR-06: Nutrition and Agriculture Interface   Credits: 3

Food situation in India and in the world, food production and consumption trends; food balance sheets. Role of nutrition in agricultural planning and national development.
Linkages between agricultural practices; food production, food distribution and nutritional status; food crop failure and malnutrition; poverty and vicious cycle of low food production ; consumption indicators, nutritional status indicators and their role in agricultural planning.
Agricultural development and its effect on food availability; effect of food production and economic policies on food availability; impact of physical resources, farming systems, cropping system, inputs and manipulation, agricultural marketing system, post harvest processing of foods on food and nutrition situation; food distribution systems .
Food and nutrition security at national and household level; nutrition policy implementation; nutritional impact of agricultural programmes, food price control and consumer subsidy; contribution of national and international organization for agricultural development.

Suggested Readings:
1. Census 1981, 1991, 2001.
2. UNICEF 1999, The State of World's Children. Oxford University Press.
3. RDF Primer 2004,Retrieved January 23, 2006, from http://www.w3.org/RDF/
4. RDF Vocabulary Description Language 1.0: RDF Schema 2004, Retrieved January 23, 2006, from http://www.w3.org/TR/rdf-schema/
5. OWL Web Ontology Language 2004, Retrieved January 23, 2006, from http://www.w3.org/TR/owl-features/

HSPR-07: Practical Based on Course HSPR-04   Credits: 1

Handling of equipment and instruments; preparation of samples, solutions and buffers; quantitative estimation of proximate principles, minerals and vitamins by use of colorimetry, flame photometry, UV spectrophotometer; chromatography, atomicabsorptionspectro photometerand photofluorometry, analysis of antinutritional factors; estimation of protein and starch digestibility; fractionation of protein; food adulteration.

Suggested Readings:
1. AOAC 1995, Association of Official Analytical Chemists. Washington, DC.
2. Sawhney SK & Singh R. 2000, Introductory Practical Biochemistry. Narosa.
3. Techniques of Food Analysis – Andrew L Winton & Kate Barber Winton, 2001, Published by Agrobios (India) Ltd.
4. Wansink B, van Ittersum K, Painter JE. 2005, How descriptive food names bias sensory perceptions in restaurants. Food Qual Pref .
5. Earle M., Earle R., Anderson a., Food Product Development 2007.

HSPR-08: Practical Based on Course HSPR-05   Credit: 1

Sensory evaluation, methods, training of judges, score card preparation. Selection and modification of food product to be developed. Formulation and standardization of products. Objective and subjective evaluation of the products. Evaluation of consumer acceptability. Packaging and sale of products. Preparation of video film for media.

Suggested Readings:
1. DeBurca, P and Ledwith, A 2000, 'The way to a customer's heart is through new foods!' in AMT Research Report, AMT Ireland.
2. Earle, M.; Earle, R.; Anderson, A., Food Product Development, 2001, Woodhead Publishing.
3. India 2001, A Reference Annual. Publication Division, Ministry of Information about Broad casting, Govt. of India.
4. Matz SA. 2004, Formulating & Processing Dietetic Foods. CHIPS Publ.
5. V.K. Joshi, Sensory Science Principles and Application in Food Evaluation, 2006, Agrotech Publishing Acdemy, Udaipur
6. S.C. Srivastava, Product Development in Food Processing Industry, June 2009, Food Processing Enterprises.

Group- B - EXTENSION AND COMMUNICATION

HSPR-09: Global Extension Systems   Credits: 4

Extension systems in India; Extension efforts after independence -Community Development Programme – Genesis and critical appraisal; Panchayati Raj Institutions; Area and target oriented programme – IAAP, T& V; Special programmes for poor, women and children -IRDP, TRYSEM, DWCRA; JRY, IAY, SGSY. Extension Approaches to rural development; Adult literacy programme -Need, Importance and Objective, National Literacy mission, Post literacy activities; Support structures and their functions – DRDA, NREGP, Central Social Welfare Board, State Social Welfare Board, NABARD; National Level Voluntary Agencies – CAPART and KVIC; ICAR extension systems- KVK, NATP, IVLP, ATIC, NAIP, AICRP. Role of SAUs in rural development; role of international organizations in rural development; Review of five year plans in India; privatization of extension services-scope and limitations. Comparative extension system of selected developed and developing countries: USA, UK, Israel, China, Pakistan, Japan and Brazil with brief history, approaches, organizational structure, linkage with research and extension methods used; its comparative analysis with Indian extension system.

Suggested Readings:
1. Axinn George H & Thorat SS. 1972, Modernizing Agricultural World Wide. Oxford & IBH.
2. Cernea MM, Russel JFA & Coulter JK. (Eds.). 1983, Agricultural Extension by Training and Visit- The Asian Experience. The World Bank Washington D.C.
3. Cernea MM, Russel JFA & Coulter JK. (Eds.). 1983, Agricultural Extension by Training and Visit- The Asian Experience. The World Bank Washington D.C.
4. Dantwala ML & Barmeda JN. 1990, Rural Development Approaches and Issues, Indian Ag. Dev. Since Independence. Oxford & IBH.

5. Dantwala ML & Barmeda JN. 1990, Rural Development Approaches and Issues, Indian Ag. Dev. Since Independence. Oxford & IBH.
6. Dhama OP & Bhatnagar OP. 1991, Communication for Development. Oxford & IBH.
7. Mondal S & Ray GL. 2007, A Text Book of Rural Development. Kalyani.
8. Ray GL. 2006, Extension Communication and Management. Kalyani.
9. Rivera WH. 1987, Agricultural Extension World Wide Issues, Practices and Emerging Pririties. Croom Helm.
10. Rivera WH. 1987, Agricultural Extension World Wide Issues, Practices and Emerging Pririties. Croom Helm.
11. Singh H. 1985, Rural Development in India. Print Well Publ.
12. Singh H. 1985, Rural Development in India. Print Well Publ.
13. Singh RP, Mathur PN & Kumar GAK. 1999, Extension Education - A
14. Handbook for Extension Personnel. IFWA, IARI, New Delhi.
15. Swanson BE, Bants RP & Sofrenko AJ. 1984, Improving Agriculture Extension - A Reference Manual. FAO.
16. Vanden Ban AW & Hawkins HS. 1988, Agriculture Extension. Longman Scientific Technicals.

HSPR-10: Educational Technology   Credits: 2

Teaching learning process: meaning and characteristics of teaching and learning; teaching learning process, maxims of teaching which facilitate teaching learning process, stages, forms and levels of teaching and learning. Motivation- concept, importance and techniques. Meaning and scope of educational technology; curriculum design and development; lesson planning: concept and methodology; teaching learning strategies: microteaching, programmed instruction, simulation role-play, team teaching, experiential learning, traditional media, ICT, video 'production and multimedia presentations etc. Genesis and trends in modern education; management of formal and non formal education in India; vocationalization of education; distance education; guidance and counseling.
Evaluation of instructions effectiveness: competence based question paper; reliability and validity of question papers.

HSPR-11: Visual Communication   Credits: 2

- Visual Communication – concept, advantages, limitations, types formations and classification
- Non – verbal communication concept, types and features
- Theories of visual perception
- Criteria for selection and preparation of Visual aids
- Graphic communication – concept, types, preparation, advantage and limitations
- Role of colours in visual communication
- Designing message, Digital video material presentation of scientific data
- Pre-testing and evaluation of visuals, scanning of visuals

HSPR-12: Practical Based on Course HSPR-10   Credits: 2

Designing a course curriculum, preparation of lesson plans of selected topics; preparation and use of different instructional material; conducting selected, teaching lessons; exercises on teaching learning strategies; reading and speech exercises; construction of competency based question paper and seminar organization.

Suggested Readings:
1. Kemp Jerrold E. 1985, Planning and Producing Audio Visual Materials. Harper

& Row.
2. Kochhar SK. 1985, Methods and Techniques of Teaching. Sterling Publ.
3. Kulkarni SS. 1986, Introduction to Educational Technology. Oxford & IBH.
4. Robert Heinich 1990, Instructional Media. MacMillan.
5. Vedanayagam EG. 1988, Teaching Technology for College Teachers. Sterling Publ.

HSPR-13: Practical Based on Course HSPR-11   Credits: 2

- Preparation of low cost projected and non-projected visuals.
- Designing and layout of charts, posters, flash cards etc.
- PowerPoint presentation.
- Generating computer aided
- Presentation graphics.
- Scanning and evaluation of visuals.

Suggested Readings:
1. Kemp Jerrold E. 1985, Planning and Producing Audio Visual Materials. Harper & Row.
2. Kochhar SK. 1985, Methods and Techniques of Teaching. Sterling Publ.
3. Kulkarni SS. 1986, Introduction to Educational Technology. Oxford & IBH.
4. Robert Heinich 1990, Instructional Media. MacMillan.
5. Vedanayagam EG. 1988, Teaching Technology for College Teachers. Sterling Publ.

Group- C - HUMAN DEVELOPMENT

HSPR-14: Children with Developmental Challenges   Credits: 2

Classification of developmentally challenged children, current statistics, its implications on the quality of life. Multi disciplinary view of children with special needs. Remedial programmes for different types of special needs- mental deficiency, sensory disabilities, neurological disorders, physically challenged. Special programmes for the gifted. Characteristics, assessment, educational and vocational interventions. Policies, Government provisions, Concessions, Facilities and Legislations for challenged children.

HSPR-15: Advances in Family Studies   Credits: 2

Definition and changing patterns of Indian family, different approaches to family studies: Nature and importance of conceptual framework, Institutional framework, Structural functional framework, Developmental framework, Interactional framework. Sociological viewpoint of family by Persons. Research methodology-inter disciplinary approaches to family measurement. Psychological approaches to assessment in family. The Psychiatric approach, Interactive approach-measurement of marital roles and relationship, Ethnographic approach, Demographic approach. Ethics in family research, Current issues for research in Indian family, Fatherhood: Concept. Changing role of parents in parenting, Disorganized and reorganized families, marital distress, psychiatric disorder and family therapy. Alternate family patterns -single parent families, female headed households, dual career families, sibling families etc. Adoptive families. National policies and programmes for family welfare. Theoritical developments in marital and family therapy, schools for family therapy, structured, strategic, experiemental family and integrated family therapy.

HSPR-16: Trends and Issues in Human Development Credits: 2

Classical and contemporary theoretical orientation to Human development: regulation of development – Developmental psychology to Developmental Science from deficit to diversity in development. Consistency of concepts, phenomena and methods of study – foundations of developmental thinking, multilevel nature of developmental processes ; constructing general model for development – developmental behaviour genetics - Cognitive and emotional development – dynamic structure in cognitive and emotional development – growth cycle, brain activity. Dynamics of stability and variability in development – role of experience in development – optimal experience theory – human action perspective to development developmental diversity and regularity- intentional personal development – personal control over development. Life span theory in development five levels of analysis – life cause theory basic concepts life transitions and historical change – future directions for life course and behaviour genetics – religious and spiritual development through life span – positive and negative correlates.

Suggested Readings:
1. Berk Laura E. 1989, Child Development. Allyn & Bacon.
2. David Ausubel & Ednaund V Sullivan 1970, Theory and Problems of Child Development. Grune & Stratton.
3. Dolly Singh 1995, Child Development – Issues, Policies and Programme. Kanishka Publ.
4. Handbooks of Child Psychology. 1998 & 2006, Vol. IV. John Wiley & Sons.
5. Saraswathi TS & Kaur B. 1993, Human Development and Family Studies in India. Sage Publ.

HSPR-17: Parent and Community Education Credit: 1

Concept and history of parent education; with special reference to India; Objective and theoretical approaches to parent education programmes. Basic approaches to communication; group, mini group approach, large group and individual approaches, single and multi- media approach. Distance home education; parent education in school and community; teachers as a parent educator. Communication techniques; written media/ printed matter and visual media. Increasing competency of a parent educator; knowledge of the subject matter, training of personnel. Special projects – open house parent training centres; parent involvement in community programmes. Special target groups for parent education; parents of young children, economically and socially backward, adopted, divorced, single and other needy parents living in urban, slum and rural areas, developmental problems and disability during childhood and adolescence.

HSPR-18: Gender Issues in Human Development and Family Relations Credits: 2

Concept of gender- its biological and socio-cultural connotations. Importance of gender differences in human development. Gender theories- gender orientation theory of Sandra Bem, gender schema theory, theory of ego development and gender. Demographic challenges to family ecology, gender issues in family involvement and cohesiveness (socialization, family roles, responsibilities and family adjustment) impact of gender roles, responsibilities and socialization practices. Working towards family solidarity and social well being (values and ethics in the promotion of happy family life). Changing trends in gender role orientation, its socio- economic and cultural impact on the family and society.

HSPR-19: Advances in Life Span Development Credit:1

Life span development; Physical development, psycho-motor development; role of heredity and environment, recent trends in assessing pre-natal and neo-natal status.

Genetic research and its influence on child's development, current trends in physical, motor, intellectual, socio-emotional, moral development of children from birth to adolescence, socialization practices and influencing factors and impact of social-emotional deprivation on different stages of development. Culture and its impact. Emotional maturity, stability and catharsis. Personality changes in self perceptions and gender role development through different developmental stages, influence of cultural factors. Integrated view of development from a life span perspective- recent research trends in human development issues.

HSPR-20: Practical Based on Course HSPR-14   Credit: 1

Study of etiology, characteristics, diagnosis of children with different disabilities, conducting individual home based intervention by collaborating with other professionals and also with institutions for center-based intervention- schools, clinics, also with pediatric wards, special schools. Collaborative work with professionals in development of intervention packages for children with special needs.

Suggested Readings:
1. Cruickshank WH & Johnson GU. 1970, Education of Exceptional Children. Prentice Hall.
2. Kar C. 1996, Exceptional Children - Their Psychology and Education. Sterling Publ.
3. Kirk SA. 1970, Educating Exceptional Children. Oxford & IBH.

HSPR-21: Practical Based on Course HSPR-15   Credit: 1

1. Appraisal of tools in family area (at least ten tools). Critical evaluation of family welfare programmes towards family welfare. Developing research proposal on current issues relating to family. Survey of family patterns in rural, slum and urban areas.
2. Case studeis of different areas of marriage and family therapy using different methods and techniques.

Suggested Readings:
1. Bharat S. 1996, Family Measurement in India. Sage Publ.
2. Roger L. 2004, Family Therapy - A Constructive Framework. Sage Publ.
3. White JM & Klein DM. 2007, Family Theories. Sage Publ.

HSPR-22: Practical Based on Course HSPR-17   Credits: 2

Conducting parent teacher meetings in urban, rural, slum areas and schools; assessing knowledge of youth and parents regarding various aspects of family and community life and starting short- term action oriented /rehabilitative programmes using various techniques of parent education; preparing educational material for community participation.

Suggested Readings:
1. Brim H, Orville G & Brjm Jr.1980, Learning to Parents, Principles, Programmes and Methods. Sage Publ.
2. Fine MJ. (Ed.). 1980, Handbook on Parent Education. Academic Press.
3. Kulkarni S. 1980, Parent Education Perspectives and Approaches. Rawat Publ.
4. Ramiya K. 1977, Minimum Content of Parent Education. A Survey of Expert's Opinion. Tata Insinuate of Social Sciences, Bombay.

HSPR-23: Practical Based on Course HSPR-18   Credit: 1

Gender analysis of mass media content, books, television and films. Interviewing children and parents to study gender socialization practices. Administering gender role orientation scale to adolescents /women interpreting the results. Case study of three generation families to identify the differences in the gender orientation roles and responsibilities. Case studies for gender role performance.

Suggested Readings:
1. Channa K. 1988, Perspective in Indian Development: Socialization,
2. Education and Women: Exploration in Gender Identity. Orient Longman.
3. Coltrance S. 1997, Gender and Families. Fine Forge Press.
4. Gherardi S. 1995, Gender Symbolism and Organizational Structures. SagePubl.
5. Narsimhan S. 1999, Empowering Women An Alternative Strategy for Rural India. Sage Publ.

HSPR-24: Practical Based on Course HSPR-19   Credit: 1

Study of physical, motor, social, emotional, intellectual, language, moral and personality development at different ages, using standard measurement tools/instruments, writing interpretative reports for parents, teachers and referral services.

Suggested Readings:
1. Dattan N Resse. HW. (Eds.). 1974, Life Span Developmental Psychology. Academic Press.
2. Kail RV & Cavaraugh JC. 2004, Human Development – A Life Span View. Thompson Learning.
3. Santrock JW. 2006, Life Span Development. Mc Graw Hill.

Group-D - CLOTHING AND TEXTILES

HSPR-25: Technical Textiles   Credits: 2

Developments in Nano-fibre and microfibre non-wovens; importance and classification of technical textiles- types of fiers, materials. Medical Textiles; Special textiles for industrial applications; automotive textiles; Industrial textiles. Agro textiles; geo-textiles; Phase Change Materials; Shape Memory Materials; Chromic Materials. Conductive Materials and other Functional Materials- characteristics and its applications; Smart textiles – factors affecting the selection and uses.

HSPR-26: Eco-Textiles   Credits: 3

Industrialization, eco-balance and textile ecology. Air, noise and water pollution by mechanical and chemical textile processing and their effect. Treatment and disposal of textile effluents. Treatment processers of sewage. Health hazards of textile workers working in varius textile units and their remedial measures. Banned dyes and auxiliarite. Eco-friendly production and processing to textiles with special reference to organic and naturally coloured cotton, natural dyes and detergents etc. Indian and International environmental legislations.Eco labeling, management and auditing.

Suggested Readings:
1. Mark KH, Woodlings & Atlas SM. 1971, Chemical after Treatment of Textiles. John Wiley & Sons.
2. Skinkle JH. 1972, Textile Testing. D.B. Taraporewala.

HSPR-27: Non-Woven Textile   Credits: 3

Introduction, history, terms and definitions of nonwoven fabrics, characteristics and properties of Nonwoven fabrics, polymers, fibres and binders. Terminology of non-woven; and types of web formation, bonding and finishing processes, felt fabrics, needle punched fabrics, spun laced fabrics, dry & wet laid non-woven fabrics; spun bonded and stitch bonded non- woven fabrics; properties and end uses; finishing non-woven. Trends in non-woven technology, scope of non-woven textiles, identification of nonwoven fabrics. Testing and evaluating of nonwovens; Laminated fabrics.

Suggested Readings:
1. Gohi EG & Vilensky. 1993, Textile Science. CBS.
2. Hall AJ. 1995, Students Hand Book of Textile Science. Newness Butterworths.
3. Lewin M & Pearce EM. (Eds.). 1998, Handbook of Fibre Chemistry. Marcel Dekker.
4. Vidyasagar PV. 1998, A Handbook of Textiles. Mittal Publ.

HSPR-28: Apparel Quality Analysis   Credits: 2

Quality control- scope and functions of quality control; Quality specifications and standards in raw material purchasing, quality control in spreading, cutting and bundling products. quality factors in sewing, pressing, folding & finishing; quality aspets of trims and fashions. Standards- sources of application; national and international organisation for standards. Inspection techniques; quality auditing system.

HSPR-29: Practical Based on Course HSPR-25   Credits: 1

Survey of avaliable technical textiles; development of library of technical textiles; Project work.

Suggested Readings:
1. Allison Mathews 1994, Medical and Hygiene Textile Production. Intermediate Technology Publ.
2. Cookling Gerry 1997, Garment Technology for Fashion Designers. Blackwell Science.
3. Padmanabhan AR. 1988, A Practical Guide to Textile Testing. SITRA, Coimbatore. Prentice Hall.
4. Skinkle JH. 1972, Textile Testing. D.B. Taraporewala.

HSPR-30: Practical Based on Course HSPR-28   Credit: 1

Visit to an apparel industry; Inspection of raw material – classification and analysis of fabric defects; Study of specification sheets - various garments; Analysis of sewing & fastners quality; Study of quality auditing system in the industry; Quality analysis of selected garments available in the market.

Suggested Readings:
1. Gerry Cooklin. 1991, Introduction to Clothing Manufacture. Blackwell.
2. Gerry Cooklin. 1997, Garment Technology for Fashion Designer's. Blackwell.
3. Jacob Solinger. 1980, Apparel Manufacture. Van Nostrand Reilfold.
4. Latheam Barbara & Carr Harold 1999, The Technology of Clothing Manufacture. Blackwell Science.
5. Pradeep V Mehta. 1998, Managing Quality in Apparel Industry. New Age International.
6. Ruth Glock. 1990, Apparel Manufacturing. Macmillan Publ.

Group-E - FAMILY RESOURCE MANAGEMENT

HSPR-31: Globalization And Consumer Economics   Credits: 2

The ontology of consumer economics: perspectives and viewpoints. Marketing and customer behaviour: Human behaviour v/s Product behaviour; Model of consumer motivation and behaviour. Individual predisposition in marketing. Group influences in marketing. Consumer decision processes. Aggregate consumer behaviour overtime: Diffusion of innovations; Brand loyalty. Globalization, Liberalization and Privatization-its impact on consumer behaviour. The W.T.O: The issues for consumers. Codex Alimentarius Commision: Its implications for consumers. The Services: consumer perspective and implications; The inspection into transparency through citizen's charter. Review Government programmes/ Schemes designed to: Increase family financial security; Increase family food security; Generate consumer awareness. Consumer Protection: Problems and prospects; Laws and Regulations; Role of Media and Organizations. Managerial and Research implications of consumer issues.

HSPR-32: Advanced Housing   Credits: 2

Historical perspective of the architectural features of buildings – Structural features of residential buildings in different geo-climatic conditions - Social-cultural and economic issues in housing. Housing stock quality, demand and supply in urban and rural areas of India - Role of Government and non-government organizations in providing and regulating housing needs. Ancient Science of house design - Emerging techniques in the house construction - Low-cost building materials and fabrication techniques – Eco and Ergo-friendly house design - House wiring, sanitary fittings, acoustics -Rain water harvesting structures for houses. Estimation of cost and housing finance - Recent developments in building Bye-Laws - Housing research- Landscaping planning.

HSPR-33: Managerial Dimensions for Special Groups   Credit: 1

Characteristics and status of people with special needs and mentally challenged children and elderly. Theoretical perspectives on efficiency, comfort and safety: Physical environment: Architectural dimensions- flooring, stairs, storage, workstations, furniture, fixtures and fitments, equipment. Indoor Environment- Light, noise, humidity and temperature. Managerial Dimensions- Time, money, energy, food and health, psycho- social; External environment support.

HSPR-34: Practical Based on Course HSPR-31   Credits: 2

Conducting case studies highlighting implications of citizen's charter in utilization of services. Designing modules for creating awareness in consumer protection. Planning and implementing consumer guidance and counseling centre. Readings in current consumer and marketing issues and holding panel discussion.

Suggested Readings:
1. David L. 2002, Consumer Behaviour. Tata McGraw Hill.
2. Ghosh AK. 2003, Jobs and Incomes in a Globalization World. ILO.
3. Nayar BR. 2007, India's Globalization. Vistaar Publ.
4. Schiffman LG. 2004, Consumer Behaviour. Prentice Hall.
5. Sharma AK. 2006, Consumer Behaviour. Global Vision Publ.
6. Siddique A. 2007, India and South Asia-Economic Development in the Age of Globalization. ME Sharpe.
7. Sivkumar GD. 2003, Consumer Protection and Redressal Machinery in India. Himalaya Publ.

HSPR-35: Practical Based on Course HSPR-32   Credits: 2

Analysis of building forms in different geo-climatic region – Visit to housing development organization and building design centers – Evolving Eco, Ergo and Space saving house plan for selected geo-climatic region for different socio-economic categories through CAD Estimation of Cost of construction - Assessment of existing house plans and suggesting cost effective renovations - Landscape planning.

Suggested Readings:
1. Ambadker SN. 2000, Rural Housing: Agro-socio-economic Impact. Special Indian Ed. Agrobios.
2. Lal AK. 1999, Handbook of Low Cost Housing, New Age International.
3. Mahadeva M. 2002, Housing in India: The Situation, Development and Challenges. Orient Longman Publ.
4. Morris EW. 1979, Housing Family and Society. John Wiley & Sons.
5. RajaRao YN & Subrahmanyam Y. 2002, Planning and Designing of Residential Buildings. Standard Publ.

HSPR-36: Practical Based on Course HSPR-33   Credit: 1

Appraisal of needs and coping strategies adopted by people with special needs at various levels through case studies. Presentation of reports. Inventory of external facilitators and services available as management catalysts. Developing conceptual management models. Planning simulated environments for comfortable living. Analysis of service centers catering to people with special needs and presenting report.

Suggested Readings:
1. Bridger RS. 1994, Introduction to Ergonomics. McGraw Hill.
2. Dalela S & Saurabh. 1999, Textbook of Work Study and Ergonomics. Standard Publ.
3. Grandjean E. 1978, Ergonomics of the Home. Taylor & Francis.
4. Ian G. 2006, Applied Ergonomics Handbook. Butterworths.
5. Panero J Zelnik. 1979, Human Dimensions and Interior Space. The Architectural Press.
6. Singh S. 2007, Ergonomics Interventions for Health and Productivity. Himanshu Publ.

Mathematics

(Department of Mathematics)

Preamble

Every student admitted in Mathematics for the Ph. D. programme will be required to pass a course work of minimum 20 credits. The division of this 20 credit course work is in three categories. Category-A (3 credits) courses are compulsory for all Ph. D. students of the Faculty of Science. Category-B (7-credits) courses are discipline-specific courses. Category-C (10 credits) courses are research theme- specific courses.

OUTLINE

Discipline-Specific Courses   Credits: 7

(Compulsory for all the research scholars)

Course Code	Title	Credits
GROUP-I		
MTPC-01	Real and Complex Analysis	4
MTPC-02	Stochastic Differential Equations	4
MTPC-03	Analysis on Manifolds	4
MTPC-04	Differential Equations	4
MTPC-05	Functional Analysis	4
MTPC-06	Numerical Methods	4
MTPC-07	Numerical Optimization	4
MTPC-08	Theory of Nonlinear Optimization	4
MTPC-09	Nonlinear Dynamical Systems	4
MTPC-10	Convection in Fluid and Porous Media	4
MTPC-11	Fourier Analysis and Approximation Theory	4
GROUP-II		
MTPC-12	Operations Research	4
MTPC-13	Gravitation	4
MTPC-14	Structures on Differentiable Manifolds	4
MTPC-15	Advanced Topology	4
MTPC-16	Numerical Solution of Partial Differential Equations	4
MTPC-17	Integral Equations	4
MTPC-18	Fuzzy Sets and Applications	3
MTPC-19	Wavelets	4
MTPC-20	Bio-Mechanics	3
MTPC-21	Module Theory	3

Research Theme-Specific Courses   Credits: 10

Any **TWO PAPERS** out of the following (MTPR-01 to MTPR-20) to be opted by a research scholar		
MTPR-01	Engineering Hydrology	4
MTPR-02	Computational Fluid Dynamics	4
MTPR-03	Magneto hydrodynamics	4
MTPR-04	Time Series Analysis	4
MTPR-05	Fuzzy Optimization and Decision Making	4
MTPR-06	Category Theory	4
MTPR-07	Fuzzy Topology	4
MTPR-08	Cosmology-I	4
MTPR-09	Cosmology-II	4
MTPR-10	Boundary Layer Theory	4
MTPR-11	Thermal Instabilities and Methods	4

MTPR-12	Advanced Numerical Analysis	4
MTPR-13	Advanced Ring and Module Theory	4
MTPR-14	Calculus in Banach Spaces	4
MTPR-15	Optimization and Non-smooth Analysis	4
MTPR-16	Operator Theory	4
MTPR-17	Banach Algebra	4
MTPR-18	Summability Theory	4
MTPR-19	Approximation of Functions by Summability Operators	4
MTPR-20	Concept of Epidemiology and its Applications	4
Compulsory for all the research scholars		
MTPR-21	Preparation and Presentation of the Research Plan Proposal	**2**

COURSE CONTENTS

MTPC-01: Real and Complex Analysis   Credits: 4

Real Analysis:
Infinite product and its convergence, uniform convergence of infinite product, double series, double series of positive reals and its convergence, double series of complex numbers and Blaschke product, Gamma function and its asymptotic behaviour, repeated integrals, Weiestrass approximation theorem.

Complex Analysis:
Elementary properties of analytic functions and complex integration, Meromorphic functions, poisson integral, Jenson's theorem, Carleman's theorem, Littlewood's theorem, singularities, Riemann surfaces and properties, Riemann zeta function, Riemann hypothesis, Hadamard's theorems, conformal mappings, Riemann mapping theorem, Dirichlet's series.

Suggested Readings:
1. C.D. Aliprantis, 1998, Principle of Real Analysis, 3rd Edition, Academic Press.
2. J.B. Conway: Functions of one Complex Variables, Springer/ Narosa, New Delhi.
3. E. Hewitt, K. Stromberg, 1975, Real and Abstract Analysis. Springer.

MTPC-02: Stochastic Differential Equations   Credits: 4

Stochastic Analogs of Differential Equations:
Filtering process: stochastic approach to deterministic boundary value problem, stochastic control.

Probability spaces, random variables and stochastic processes, Brownian motion, white noise, conditional expectations.

Itô integral:
Construction, properties, extensions; one- and multi-dimensional Itô formulae, the Martingale representation.

SDEs, examples and some solution methods of linear SDEs, important models.

Diffusions, Markov properties, Generator of an Itô diffusion, characteristic operator, Martingale problem.

Combined Dirichlet-Poisson problem, Dirichlet problem, Poisson problem.

Hamilton–Jacobi–Bellman equation (stochastic control), stochastic control problems with terminal conditions.

Suggested Readings:
1. Bernt Oksendal, 2006, Stochastic Differential Equations, An Introduction with Applications, Springer.
2. Kazimierz Sobczyk, 2001, Stochastic Differential Equations (with Applications to Physics and Engineering, Kluwer.
3. H Kunita, 1997, Stochastic Flows and Stochastic Differential Equations, Cambridge Univ. Press.
4. Javier R Movellan, 2006, Tutorial on Stochastic Differential Equations, MP Lab Tutorials Version 6.1,
5. An Introduction to Stochastic Differential Equations – Version 1.2, Lawrence C Evans, Univ of Burkley.
6. K D Elworthy, 1982, Stochastic Differential Equations on Manifolds, Cambridge Univ. Press,
7. L W Gelhar, 1992, Stochastic Sub-surface Hydrology, Prentice Hall,

MTPC-03: Analysis on Manifolds Credits: 4

Functions on Euclidean spaces, continuity, differentiability; partial and directional derivatives, chain rule, inverse function theorem, implicit function, Riemann integral of real-valued functions on Euclidean spaces, Fubini's theorem, partition of unity, change of variables.

Integration on chains, tensors, differential forms, Poincare lemma, singular chains, Stoke's theorem for integrals of differential forms on chains (general version), fundamental theorem of calculus.

Differential manifolds(as subspaces of Euclidean spaces), differential functions on manifolds, tangent spaces, vector fields, differential forms on manifolds, orientations, integration on manifolds, Stoke's theorem on manifolds.

Suggested Readings:
1. M. Spivak, 1965, Calculus on Manifolds, Addison-Wesley.
2. J.R. Munkers, 1991, Analysis on Manifolds, Addison-Wesley.

MTPC-04: Differential Equations Credits: 4

Existence and uniqueness of initial value problems, Picard's theorem. Analytical solutions of non-linear differential equations by asymptotic methods: variational approaches, parameter expanding methods, parameterized perturbation method, iteration perturbation method, homotopy methods. Greens function and boundary value problems.

First order PDE:
Method of characteristics, wave equation, weak solutions, system of PDE.

Linear PDE:
Dimensional analysis and self similarity, regular and singular perturbation, asymptotic and complete solution.

Non-linear PDE:
Conversion of non-linear PDE into linear PDE, some exactly solvable cases, Burger's equation, singular perturbation: boundary layer idea, shallow water theory.

Suggested Readings:
1. V. Lakshmikantham, V. Raghavendra, 1997, A Text Book of Ordinary Differential Equations, Tata McGraw Hill.
2. A.H. Nayfeh, 1981, Introduction to Perturbation Methods, John Wiley.

3. F. Verhulst, 1990, Non-linear Differential Equations and Dynamical Systems, Springer.
4. P.Prasad, R .Ravindran, 1985, Partial Differential Equations, Wiley Eastern.
5. W.E. Williams, 1980, Partial Differential Equations, Oxford Univ. Press.
6. P.R. Garabedian, 1984, Partial Differential Equations, Wiley.
7. J. Kevorkian, 2000, Partial Differential Equations: Analytical Solution Techniques, Springer.
8. H. Levine, 1997, Partial Differential Equations, Amer. Math. Soc. Intl. Press.
9. G. I. Barenblatt, 1997, Scaling, Self-Similarity and Intermediate Asymptotics, Cambridge Univ. Press.
10. L. Debnath, 1997, Non-linear Partial Differential Equations for Scientists and Engineers, Birkhauser.

MTPC-05: Functional Analysis   Credits: 4

Topological Groups: Basic definition and properties.

Topological Vector Spaces: Basic definitions, Minkowski functional, separating family of seminorms, quotient spaces, metrizability, normability and spaces $C(\Omega)$, $\Re(\Omega)$, D_K, L^p, $0<p<1$., Milking Baire's category theorem: Banach-Steinhaus, open mapping and closed graph theorems, Han-Banach theorems, convex hull, weak topologies, Banach-alaogu and Krein-Milman theorems, vector-valued integration, second dual, adjoint of an operator, closed range theorem, compact operators.

Applications to Krein-Milman theorem, Grothendeik theorem, Bishop's generalization of Stone_Weiestrass theorem, Bishop's interpolation theorem, fixed point theorems, Bonsall's theorem on sums of Poisson kernels.

Suggested Readings:
1. W. Rudin, 1991, Functional Analysis, 2nd edition, Tata McGraw-Hill.
2. W. Rudin, 1993, Real and Complex Analysis, 3rd edition, Tata Mcgraw-Hill.
3. F. Treves, 1967, Topological Vector Spaces, Distributions and Kernels, Academic Press.
4. L.H. Loomis, 1953, An Introduction to Abstract Harmonic Analysis, Van-Nostrand.
5. A. Browder, An Introduction to Functional Algebra, Benjamin.

MTPC-06: Numerical Methods   Credits: 4

Theory: Credits: 3

Finite Difference Methods for elliptic, parabolic and hyperbolic problems, Stability, consistency and convergence of finite difference schemes.
Finite Element Analysis, integral formulations and variational methods, finite element discretization of continuum, shape functions, element matrices. Finite element Method for boundary value problems of ordinary and partial differential equations.

Introduction to Finite Volume Method and its application to solve boundary value problems.

Practicals: Credit: 1
Practicals on numerical computation of the problems based on the above methods using a programming language or software.

Suggested Readings:
1. A. Tveito, R. Wintther, 1998, Introduction to Partial Differential Equations: A Computational Approach, Springer.

2. A. Quarteroni, A. Valli, 1997, Numerical Approximation of Partial Equations, Springer.
3. M.K. Jain, S.R.K. Iyengar, R.K.Jain, 1994, Computational Methods for Partial Differential Equations, Wiley Eastern.
4. J.N. Reddy, An Introduction to the Finite Element Method, McGraw Hill Inc.
5. Daryl L. Logan, 2007, A First Course in the Finite Element Method, Cengage Learnin.

MTPC-07: Numerical Optimization   Credits: 4

Theory: Credits: 3

Non-linear optimization: Constrained and unconstrained optimization techniques, some direct search and indirect search methods.

Stochastic programming: uncertainty and modelling, probabilistic spaces and random variables, probabilistic programming basic properties, theory and solution methods, relationship with other decision making models.

Generalized convex functions, linear and nonlinear fractional programming: theory and computational methods. Multi-objective optimization: theory and computational methods.

Evolutionary methods and global optimization: genetic algorithm simulated annealing. Neural network based optimization. Decision making in fuzzy environment, Fuzzy optimization: theory and computational methods. Comparative study of probabilistic, possibilistic and fuzzy programming by case study.

Practicals: Credit: 1
Practicals on numerical computation of the problems based on the above optimization methods using a programming language or optimization software.

Suggested Readings:
1. J. Nocedal, S.J. Wright, 1999, Numerical Optimization, Springer.
2. R. Fletcher, 1980, Practical Methods of Optimization. John Wiley.
3. P. Kall, 1976, Stochastic Linear Programming, Springer.
4. John R. Birge, Francois Louveaux, 1997, Introduction to Stochastic Programming, Springer.
5. B.D. Craven, 1988, Fractional Programming, Heldermann Verlag.
6. Charnes A, Cooper W.W, 1961, Mathematical Models and Industrial Applications of Linear Programming, Vol. 1 & Vol 2, Wiley NY.
7. Kendel A, 1986, Fuzzy Mathematical Techniques with Applications, Addison Wisely.
8. M.J. Schniederjans, 1995, Goal Programming: Methodology and Applications, Kluwer Academic Publ.
9. Y.J. Lai, C.L. Hwang, 1995, Fuzzy Mathematical Programming: Methods and Applications, Springer-Verlag.
10. Y.J. Lai, C.L.Hwang, 1994, Fuzzy Multiple Objective Decision Making: Methods and Applications, Springer-Verlag.
11. D.E. Goldberg, 2004, Genetic Algorithm in Search, Optimization and Machine Learning, Pearson.
12. L. Fausett, 2005, Fundamentals of Neural Networks, Pearson.

MTPC-08: Theory of Nonlinear Optimization   Credits: 4

Introduction and Problem Formulation, Existence Theorems for Minimal Points:

Problem Formulation, Existence Theorems, Set of Minimal Points, Application to Approximation Problems, Application to Optimal Control Problems

Generalized Derivatives:
Directional Derivative, Gateaux and Frechet Derivatives, Subdifferential, Quasidifferential, Clarke Derivative.

Tangent Cones:
Definition and Properties, Optimality Conditions, A Lyusternik Theorem.

Generalized Lagrange Multiplier Rule:
Problem Formulation, Necessary Optimality Conditions, Sufficient Optimality Conditions, Application to Optimal Control Problems.

Duality:
Problem Formulation, Duality Theorems, Saddle Point Theorems, Linear Problems, Application to Approximation Problems.

Some Special Optimization Problems:
Linear Quadratic Optimal Control Problems, Time Minimal Control Problems.

Suggested Readings:
1. Johannes Jahn, 2007, Introduction to the Theory of Nonlinear Optimization, Third Edition, Springer.
2. V. Barbu and T. Precupanu, 1986, Convexity and Optimization in Banach Spaces, Editura Acad. Bucaresti.
3. J. Jahn, 2004, Vector Optimization - Theory, Applications, and Extensions, Springer.

MTPC-09: Nonlinear Dynamical Systems   Credits: 4

Picard's theorem, Boundedness of solutions, Omega limit points of bounded trajectories. Stability via Lyapunov's direct method, Converse Lyapunov's theorems, Brokett's theorem, Applications to control system; Stable and unstable manifolds of equilibria, Stable manifold theorem, Hartman-Grobman theorem, Examples and applications, Center manifold theorem, Normal form theory, Examples and applications to nonlinear systems and control; Poincare map, and stability theorems for periodic orbits; Bifurcation theory, forward bifurcation, backward bifurcation, Hopf – bifurcation, Examples and applications.

Suggested Readings:
1. Lawrence Perko, 2001, Differential Equations and Dynamical systems. Springer-Verlag.
2. F. Verhulst, 2001, Non-linear Differential Equations and Dynamical Systems, Springer-Verlag.
3. Hassard et. al, Theory and Applications of Hopf Bifurcation, London Mathematical Society Lecture Note Series. 41, Cambridge University Press.

MTPC-10: Convection in Fluid and Porous Media   Credits: 4

Fundamentals of hydrodynamic stability, Rayleigh-Benard convection, concepts of porous medium, Darcy's law, Brinkman equation, equations for conservation of mass, momentum and energy in fluid and porous medium. Boussinesq approximations, boundary conditions, normal modes, cell patterns, heat and mass transfer in fluid and porous medium. convection under rotation. magnetic field and solute gradient. nonlinear stability. Introduction to nanofluids, ferrofluids and polar fluids.

Suggested Readings:
1. D.A. Nield , A. Bejan, 2006, Convection in Porous Medium, Springer.
2. P.G. Drazin, W.H. Reid, 1982, Hydrodynamic Stability. Cambridge Uni. Press,.
3. S. Chandrasekhar, 1981, Hydrodynamic and Hydromagnetic Stability, Oxford Univ. Press.

MTPC-11: Fourier Analysis and Approximation theory   Credits: 4

Convergence problem, Dirichlet's integral, n^{th} partial sum of Fourier series and its conjugate series, Riemann-Lebesgue theorem, convergence tests, Dini's test, Jordan's test, de la Vallee-Poussin's test, relation between the tests of Dini' Jordan and de la Vallee-Poussinn tests, Summation of series by arithmetic means, Summability of Fourier series, Fejer's theorem, Weierstrass's approximation theorem, almost everywhere summability, Fejer-Lebesgue theorem, a continuous function with a divergent Fourier series, order of partial sums, integration of Fourier series, an example of convergent trigonometric sries which is not Fourier series, Parseval's theorem for continuous functions.

Function of class L^2; Bessel's inequality, Parseval's theorem for functions of class L^2, the Riesz-Fischer theorem, properties of Fourier coefficients, uniqueness of trigonometric series, Cantor's lemma, Riemann's first and second theorems.

Approximation of functions by trigonometric polynomials, Best approximation, functions of Lip α , Lip(α, r) and Lip($\xi(t)$,r) classes , degree of approximation of functions by (C,1), (E,1), (C,1)(E,1), (N, p_n) means of their Fourier Series.

Suggested Readings:
1. E.C. Titchmarsh, Theory of Functions, 2nd Edition, Oxford Univ. Press.
2. A. Zygmund, Trigonometric Series Vol 1 & Vol 2, Cambridge Univ. Press.
3. H.Hardy, Divergent Series, Oxford Clarendon Press.
4. Rath, S. Nanda, Sequence, Summability and Fourier Analysis, Narosa Publ.
5. De Boor, 1986, Approximation Theory, American Math. Soc.
6. W. Cheney, Introduction to Approximation Theory. American Math. Soc.

MTPC-12: Operations Research   Credits: 4

Game Theory: Two person zero sum games, Games with mixed strategies, Graphical solution, Solution by linear programming.

Basic Concept of Multi Objective and Multi Level Optimization.

Integer Programming, Mixed Integer Programming. Linear Fractional Programming. Goal Programming. Sensitivity Analysis and System Reliability.

Geometric Programming: Constrained and Unconstrained Minimization Problems.

Dynamic Programming: Deterministic and Probabilistic dynamic programming.

Stochastic Programming: Stochastic Linear and Stochastic Non linear Programming.

Netwok Schedulig by PERT/CPM.

Suggested Readings:
1. F. S. Hiller and G. J. Leiberman, 1995, Introduction to Operations Research, 6th Edition, McGraw-Hill International Edition.
2. G. Hadley, Nonlinear and Dynamic Programming, Addison Wesley.

3. H. A. Taha, Operations Research –An Introduction, Macmillan.
4. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.
5. S. S. Rao, Optimization Theory and Applications, Wiley Eastern.
6. N. S. Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., New Delhi.

MTPC-13: Gravitation Credits: 4

Newtonian theory : Attraction and potential of rod, disc, spherical shell and sphere. Surface integral of normal attractions-Gauss theorem, Laplace and Poission equations. Work done by self attracting systems. Distribution for given potentials. Equipotential surfaces. Einstein's Theory : Principles of equivalence and general covariance, Geodesic postulate. Newtonian approximation of general relativistic equations of motion. Heuristic derivation of Einstein's field equations, Newtonian approximation of Einstein's field equations. Schwarzschild external solution. Planetary orbit. The three crucial tests. Energy momentum tensor of a perfect fluid. Schwarzschild internal solution.

Suggested Readings:
1. S. L. Loney, 1979, *An Elementary Treatise on Statics*, Kalyani Publishers-New Delhi.
2. A. S. Ramsey, 1964, *Newtonian Attraction,* Cambridge University Press.
3. A. S. Eddington, 1954, *The Mathematical Theory of Relativity,* Cambridge University Press.
4. R. Adler, M. Bazin and M. Schiffer, 1965, *Introduction to General Relativity*, McGraw-Hill.
5. S. R. Roy and Raj Bali, 1987, *Theory of Relativity*, Jaipur Publishing House.
6. J. V. Narlikar, 1978, *General Relativity and Cosmology*, Macmillan.

MTPC-14: Structures on Differentiable Manifolds Credits: 4

Almost Hermite Manifolds: Definitions. Almost analytic vector fields, curvature tensor, linear connections, almost quaternion metric structure, submanifolds. F-connections.
Kahler Manifolds: Definition, curvature tensor, affine connections. Projective, conformal, concircular, conharmonic and Bochner curvature tensors. Contravariant almost analytic vectors, submanifolds, quaternion Kahler manifold.
Nearly Kahler Manifold: Definitions, certain properties, curvature identities, almost analytic vectors, immersions.
Almost Kahler Manifolds: Definitions, some properties, analytic vectors, conformal transformations, curvature identities, immersions.
Quasi-Kahler, Semi-Kahler Manifolds: Definitions, curvature identities, properties and immersion in a quasi-Kahler manifold.

Suggested Readings:
1. R.S. Mishra, 1984, Structures on a Differentiable Manifold and Their Applications, Chandrama Prakashan, Allahabad.
2. K. Yano, 1965, Differential Geometry of Complex and Almost Complex Spaces, Pergamon Press.

MTPC-15: Advanced Topology Credits: 4

The Stone-Cech compactification. Paracompact spaces, their properties and characterizations. Metrizable spaces and Metrization theorems. Uniform spaces, Weak uniformity, Uniformizabilty. Completion of uniform spaces.

Function spaces. Point-wise and uniform convergence.The compact open Topology. The Stone-Weierstrass theorem.

Suggested Readings:
1   S. Willard, 1970, General Topology, Addison Wesley.
2   S.W.Davis, 2006, Topology, Tata McGraw, Hill.

MTPC-16:   Numerical Solution of Partial Differential Equations   Credits: 4

Theory: Credits: 3

Numerical solutions of parabolic PDE in one space: two and three levels explicit and implicit difference schemes. Convergence and stability analysis.

Numerical solution of parabolic PDE of second order in two space dimension: implicit methods, alternating direction implicit (ADI) methods. Non linear initial BVP.

Difference schemes for parabolic PDE in spherical and cylindrical coordinate systems in one dimension.

Numerical solution of hyperbolic PDE in one and two space dimension: explicit and implicit schemes. ADI methods. Difference schemes for first order equations.

Numerical solutions of elliptic equations, approximations of Laplace and biharmonic operators. Solutions of Dirichlet, Neuman and mixed type problems.

Finite element method: Linear, triangular elements and rectangular elements.

Practicals: Based on the above contents.   Credit: 1

Suggested Readings:
1. M. K. Jain, S. R. K. Iyenger and R. K. Jain, 1994, Computational Methods for Partial Differential Equations, Wiley Eastern.
2. M. K. Jain, Numerical Solution of Differential Equations, 2nd edition, Wiley Eastern.
3. S. S. Sastry, Introductory Methods of Numerical Analysis, 2002, Prentice-Hall of India.
4. D. V. Griffiths and I. M. Smith, 1993, Numerical Methods of Engineers, Oxford University Press.
5. C. F. General and P. O. Wheatley, 1998, Applied Numerical Analysis, Addison-Wesley.

MTPC-17:   Integral Equations   Credits: 4

Classification. Modeling of problems as integral equations. Conversion of initial and boundary value problem into integral equations. Conversion of integral equations into differential equations. Volterra integral equations and their numerical solutions. Greens function for Fredholm Integral equations. Fredholm integral equations: Degenerate kernels, symmetric kernels. Fredholm Integral equation of second kind. Numerical Solution of Fredholm Integral equations.

Existence of the solutions: Basic fixed point theorems.

Integral equations and transformations: Fourier, Laplace and Hilbert transformation.

Suggested Readings:
1. Abdul J. Jerry, Introduction to Integral Equations with Applications, Marcel Dekkar Inc. NY.
2. L.G.Chambers, 1976, Integral Equations: A short Course, Int. Text Book Company Ltd.
3. R. P. Kanwal, Linear Integral Equations.
4. Harry Hochsdedt, Integral Equations.
5. Murry R. Spiegal, Laplace Transform (SCHAUM Outline Series), McGraw-Hill.

MTPC-18: Fuzzy Sets and Applications   Credits: 3

Basic Concepts of Fuzzy Sets and Fuzzy Logic:Motivation. Fuzzy sets and their representations. Membership functions and their designing. Types of Fuzzy sets.Operations on fuzzy sets. Convex fuzzy sets. Alpha-level cuts. Geometric interpretation of fuzzy sets. Linguistic variables. Possibility measure and distribution. Fuzzy rules. Fuzzy Relations and Fuzzy Arithmetic:Composition of fuzzy relations. Fuzzy numbers. Arithmetic operations on fuzzy numbers.
Fuzzy reasoning
Fuzzy mapping rules and fuzzy implication rules. Fuzzy rule-based models for function approximation. Types of fuzzy rule-based models (the Mamdani, TSK, and standard additive models). Fuzzy Implications and Approximate Reasoning:
Fuzzy Logic and Probability Theory :Possibility versus probability. Probability of a fuzzy event. Baye's theorem for fuzzy events. Probabilistic interpretation of fuzzy sets. Fuzzy measure.
Decision making in Fuzzy environment: Fuzzy Decisions, Fuzzy Linear programming, Fuzzy Multi criteria analysis, Multiobjective decision making.
Fuzzy databases and queries: Introduction, Fuzzy relational databases, Fuzzy queries in crisp databases.

Suggested Readings:
1. J. Yen and R. Langari, 2003, Fuzzy Logic: Intelligence, Control, and Information, Pearson Education.
2. G. J. Klir and B. Yuan, 1997, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice-Hall of India.
3. H.J. Zimmermann, 2001, Fuzzy Set Theory and its Applications, Kluwer Academic Publ.

MTPC-19:   Wavelets   Credits: 4

Fourier Analysis:
Fourier and inverse Fourier transforms, Convolution and delta function, Fourier transform of Square integrable functions. Fourier series, Basic Convergence Theory and Poisson's Summation formula.
Wavelet Transforms and Time Frequency Analysis: The Gabor Transform. Short-time Fourier transforms and the uncertainity principle. The integral wavelet transforms Dyadic wavelets and inversions. Frames. Wavelet Series.

Scaling Functions and Wavelets:
Multi resolution analysis, scaling functions with finite two scale relations. Direct sum decomposition of $L^2(R)$. Linear phase filtering, Compactly supported wavelets, Wavelets and their duals, Orthogonal Wavelets and Wavelet packets, Example of orthogonal Wavelets. Identification of orthogonal two-scale symbols, Construction of Compactly supported orthogonal wavelets, Orthogonal wavelet packets, orthogonal decomposition of wavelet series.

Suggested Readings:
1. C.K.Chui, 1996, A First Course in Wavelets, Academic press NY.
2. I. Daubechies, 1992, Ten Lectures in Wavelets, Society for Industrial and Applied Maths.

MTPC-20:   Bio-Mechanics   Credits: 3

External Flow: Fluid Dynamic forces acting on moving bodies. Flying and swimming. Blood flow in Heart, Lung, arteries and veins. Micro and Macro Circulation. Respiratory gas flow. The Laws of Thermo dynamics. Molecular diffusion. Mechanism in Membrances and Multiphasic structure.

Mass transport in Capillaries, Tissues, Interistitial spaces. Lymphatics, Indicator dilution method and Peristlsis.

Suggested Readings:
1   Y.C.Fung, 1990, Bio Mechanics, Springer Verlag, NY.
2   S.I. Rubinow, 1975, Introduction to Mathematical Biology, John Wiley.
3   Riccilardi, 1988, Biomathematics and Related Computational Problems, Kluwer Publ.
4   J. Keener, J. Sneyol, 2001, Mathematical Physiology, Springer
5   J.N.Kapoor, 1992, Mathematical Models in Biology and Medicine, EWP New Delhi**.**

MTPC-21: Module Theory   Credits: 3

Modules. Linear mapping. Transpose of a module, Homomorphism. Bimodules, Bilinear maps. Tensor product of modules. Exact and split-exact sequences. Small and essential submodules and their properties. Free modules, Projective modules, projective covers. Injective modules and injective envelopes.

Suggested reading:
1   F.W.Anderson and K. R. Fuller, Rings and Categories of Modules. Springer Verlag.
2   J. Lambek, Lectures on Rings and Modules, Blaisdell Publ. Co.
3   J.S. Golan, Modules and Structures of Rings, Marcel Dekkar Inc.

MTPR-01: Engineering Hydrology   Credits: 4

Fick's laws of Diffusion; Advection – diffusion equation (ADE) in different coordinate systems. Its application: solute transport in air, soil and water. Cells migration. Initial and boundary value problems.

Different methods to solve ADE: Integral transforms; Aris moment method; Purturbation method; Super imposition method; Generalized integral Laplace transformation technique supported by matrix-diagonalization; Advection diffusion multilayer method; Finite difference methods.

Inverse dispersion problems; the point dilution theory; determination of diffusion coefficient on isotropic diffusion operator with constant coefficients and variable coefficients; isotropic and anisotropic diffusion operator.

Ground water flow; Darcy law, generalized Darcy law; Equations of confined and unconfined ground water flow; steady flow into a well; unsteady flow in a confined aquifer.

Forms of sub – surface water; aquifer properties; compressibility of aquifers.
Ground water pollution; origins and physical characteristics; technical studies of ground water pollution; canonical rectangular bi-dimensional monolayer and multilayer models of pollution.

Suggested Readings:
1. D K Todd, 1980, Ground Water Hydrology, John Wiley.
2. I K Gavich, A.A. Balkema, 1997, Hydrogeodynamics.
3. E M Wilson, MacMillan, 1990, Engineering Hydrology.
4. K Subramanya, 2006, Engineering Hydrology TMH.
5. J J Fried, 1990, Ground Water Pollution (Theory, Methodology, Modeling, Practical Rules), Elsevier.

MTPR-02   Computational Fluid Dynamics   Credits: 4

(Course comprise of 60% theory and 40% practicals)
Finite difference method**:** Implicit method for pipe and starting flow in a channel, Solution of Bihormonic equation.
Finite volume method: Solution of first and second order ordinary differential equations and Laplace equation.
Finite element method: Linear and quadratic interpolation, Two-dimensional interpolation, Application to diffusion equation and viscous flow in a rectangular duct.
Grid generation: Grid generation by conformal mapping, algebraic mapping and solution of elliptic partial differential equations, application to transport equations in non-rectangular cavity.
Panel method: Panel method for inviscous incompressible and compressible flows, Moretti λ- scheme, computation of strong shocks.

Practicals: Practicals on numerical computation of the problems based on the above methods using a programming language or software.

Suggested Readings:
1. Chuen-Yen Chow, 1979, An Introduction to Computational Fluid Mechanics, John Wiley & Sons, New York.
2. Clive A. J. Fletcher, 2003, Computational Techniques for Fluid Dynamics, Vol. 1 and 2, 2nd Edition, Springer-Verlag.
3. T. K. Bose, 1997, Numerical Fluid Dynamics, Narosa Publishing House, New Delhi.
4. Frederick S. Sherman, 1990, Viscous Flow, McGraw-Hill Publishing Company, New York.

MTPR-03: Magnetohydrodynamics   Credits: 4

Basic concepts of Magnetohydrodynamics and its applicatons, Maxwell's equations, Frame of reference, Lorentz force, Electromagnetic body force, Fundamental equations of MHD, Ohm's law for a moving conductor, Hall current, Conduction current, Kinematic aspect of MHD, Magnetic Reynolds number, MHD waves: alfven's waves, Mhd waves in compressible fluid, MHD approximations, Electromagnetic boundary conditions, One dimensional MHD flow, Hartmann flow, MHD Couette flow, MHD Stoke's flow, MHD Rayleigh's flow, Hartmann-Stoke's boundary layer, Alfven's boundary layer, Two dimensional MHD flow (a) Aligned flow (b) Stagnation point flow, MHD flows in a rotating medium, Effects of Hall current on MHD flows in a rotating channel, MHD heat transfer.

Suggested Readings:
1. T.G.Cowling, 1957, Magnetohydrodynamics, Interscience Publishers, New York.
2. J.A. Shercliff, 1965, A Text Book of Magnetohydrodynamics, Pergamon Press, Oxford.
3. S.I. Pai, 1962, Magnetohydrodynamics and Plasma Dynamics, Springer Verlag, New York.
4. K. R. Cramer and S. I. Pai, 1973, Magnetofluid Dynamics for Engineers and Applied Physicists, McGraw Hill, New York.

MTPR-04: Time Series Analysis   Credits: 4

(Course comprises of 60% theory and 40% practicals)
Stochastic models and their forecasting: Time series and stochastic process. linear stationary models: Autoregressive process and Moving Average process. linear nonstationary models; Integrated Moving Average process, ARIMA process, forecasting, outlier analysis for time series.

Fuzzy Time series: Fuzzy clustering, fuzzy regression, Theory and implementation of time variant and time invariant models, fuzzy ARIMA models, Neurofuzzy models. Analysis of financial time series and case study.

Practicals: Practicals on numerical computation of the problems based on the above methods using a programming language or software.

Suggested Readings:
1. G.E.P.Box, G.M. Jenkins, G.C. Reinsel, 2003, Time Series Analysis: forecasting and control, Pearson.
2. F. Hopper, F. Klawonn, R. Krause, R. Rankler, 1999, Fuzzy Cluster Analysis, John Wiley & Sons.
3. R.S. Tsay, 2002, Analysis of Financial Time Series, John Wiley & Sons.
4. J.S. Armstrong, 2001, Principle of Forecasting, Kluwer Academic Publ.

MTPR-05: Fuzzy Optimization and Decision Making   Credits: 4

(Course comprises of 60% theory and 40% practicals)
Fuzzy sets and fuzzy logic, fuzzy relations, fuzzy equations, fuzzy regression, fuzzy data analysis, basic theory of optimization and optimization in fuzzy environment, fuzzy mathematical programming, fuzzy linear programming, fuzzy multi objective programming. Fuzzy transportation problem, portfolio selection using fuzzy decision theory, multicriteria optimization. Goal programming and fuzzy goal programming, geometric programming, fractional programming in fuzzy environment. Stochastic verses fuzzy approaches to multiobjective mathematical programming. Sensitivity analysis and case study.

Practicals: Practicals on numerical computation of the problems based on the above methods using a programming language or software.

Suggested Readings:
1. J.L.Cohan, 1988, Multi-objective Programming and Planning, Heldermann Verlag.
2. M. Sakawa, 1993, Fuzzy Sets and Interactive Multiobjective Optimization, Plenum Press.
3. John R. Birge, Francois Louveaux, 1997, Introduction to Stochastic Programming, Springer.
4. E.B. Bajalinov, 2003, Linear Fractional Programming, Kluwer Acad. Publications.
5. Charnes A, Cooper W.W, 1961, Mathematical Models and Industrial Applications of Linear Programming, Vol. 1 & Vol 2, Wiley NY.
6. Kendel A, 1986, Fuzzy Mathematical Techniques with Applications, Addison Wisely.
7. Bing-Yuan Cao, 2002, Fuzzy Geometric Programming, Kluwer Acad. Publ..
8. Y.J. Lai, C.L. Hwang, 1995, Fuzzy Mathematical Programming: Methods and Applications, Springer-Verlag.
9. Y.J. Lai, C.L. Hwang, 1994, Fuzzy Multiple Objective Decision Making: Methods and Applications, Springer-Verlag.
10. Frank K. Reilly, Keith C. Brown, 2008, Investment Analysis and Protfolio Management, South Western Publ.

MTPR-06: Category Theory   Credits: 4

Origin of category theory. Definition of category and examples(from algebra, topology, functional analysis, geometry, computer science). Large and small categories, categories and product categories. Monomorphis, epimorphisms and isomorphisms. duality.
Functors and covariant functors.

universal property. Yoneda lemma. Limits and colomits , special limits and colomits(products , coproducts etc.)

Adjointness, examples of adjointness, adjoints for preorders, reflective and coreflecive subcategories, equivalence of categories. Freyd's adjoint function theorem. Adjoints in algebra, toplogy and automata theory.

Monads. Algebra for monads. Free algebra for monads. The Kleisli category. Beck's theorem (statement only). Compact Hausdorff spaces as *T*-algebras.

Suggested Reading:
1. S. Maclane, 1997, Categories for the Working Mathematician, 2nd Edition, Springer.

MTPR-07: Fuzzy Topology   Credits: 4

Fuzzy set theory:
Basic definitions of fuzzy sets, various operations on it. Representation of fuzzy sets through α- cuts. Backward and forward operators related to functions between sets. Zadeh extension principle. Fuzzy points, belonging relations and quasi-coincidence. Some generalization of fuzzy sets including l-fuzzy sets and introductory accounts of intuitionistic fuzzy sets and rough sets.

Fuzzy topology:
Definition of fuzzy topology and its various suggested modifications. Examples, particularly the fuzzy real line, the fuzzy unit interval and fuzzy Sierpinski space. Fuzzy continuity. Initial and final fuzzy topologies. Induced fuzzy topologies. Fuzzy product topology. Fuzzy separation axioms, connectedness and compactness. Fuzzy sobriety.
Categorical aspects of fuzzy topology:
Basic concepts of category theory(categories, functions, special morphisms, adjoint functors and reflective & coreflective subcategories). The category FTS and fuzzy topological spaces and its being a topological category. The relation between FTS and the category TOP of topological spaces. The Lowen funtors. Some relative and coreflective subcategories of FTS and related categories. The categorical relation between fuzzy sobriety and locate theory.

Suggested Reading:
1. Y.-M. Liu amd M.-K.Luo, 1997, FUZZY TOPOLOGY, World Scientific.

MTPR-08: Cosmology-I   Credits: 4

Friedmann-Robertson-Walker cosmological models with cosmological constant; de-Sitter model, Lemmaitre model, Eddington-Lemaitre model. Exact solution connecting radiation and matter dominated eras of the FRW models. Thermal History of the hot big-bang models.

Suggested Readings:
1. Reter Coles, Francesco Lucchin, Cosmology, 2002: the Origin and Evolution of Cosmic Structure, John Wiley & Sons.
2. J.A.Peacock, 2002, Cosmological Physics, Cambridge Univ. Press.
3. Edward R. Harrison, 2000, Cosmology: the Science of the Universe, Cambridge Univ. Press.
4. Andrew Liddle, 2003, An Introduction to Modern Cosmology, Wiley Chichester.

MTPR-09: Cosmology-II   Credits: 4

Problems with hot big-bang cosmology, the idea of inflation in the early universe, inflationary model of Guth, problems with Guth's model, new inflationary model of universe. Observed acceleration of the present universe, motivation for dark energy,

scalar field models of dark energy, time varying cosmological constant, Quintessence, K-essence,Tachyon scalar, chaplin gas, Phantom scalar, Big rip singularity to occur in the future universe.

Suggested Readings:
1. Helge S. Kragh, 2007, Concepts of Cosmos: From Myths to the Accelerating Universe; A History of Cosmology, Oxford Univ. Press.
2. Mario Lino, 2000, The Accelerating Universe, Infinite Expansion, the Cosmological Constant and the Beauty of Cosmos, Wiley NY.
3. M. Longair, 2006, The Cosmic Century: A History of Astrophysics and Cosmology, Cambridge Univ. Press.
4. E.J. Copland, M. Sami, S. Tsujikawa, 2006, Dynamics of Dark Energy, Int. Jl. Mod. Phys. D, 15, 1753.

MTPR-10: Boundary Layer Theory   Credits: 4

Derivation of Reynolds's principal of similarity from the Nevier-Stokes equations, Frictionless flow as "Solutions" of the Nevier-Stokes equations, Nevier-Stokes equations interpreted as vorticity transport equations, Limiting cases of very large viscosity (very small Reynolds number) and very small viscous forces (very large Reynolds number), Parallel flow through a straight channel and Couette flow, Hagen-Poiseuille theory of the flow through a pipe, Flow between two concentric rotating cylinders, Stokes's first and second problems, Flow formulation in Couette motion, Flow in a pipe starting from rest , General class of non steady solutions, Stagnation in plane flow (Hiemenz flow), Two dimensional non-steady stagnation flow, Stagnation in the three dimensional flow, Flow near a rotating disk, Flow in convergent and divergent channels, Differential equations for the case of Very slow motion, Parallel flow past a sphere, The hydrodynamic theory of lubrication, Hele-Shaw flow, Flow past a wedge, Flow in a convergent channel, Flow past a cylinder, Two-dimensional laminar jet, Circular jet.

Suggested Readings:
1. H. Schlichting, 1987, Boundary Layer Theory, McGraw-Hill Book Company, New York.
2. Frederick S. Sherman, 1990, *Viscous Flow,* McGraw-Hill Publishing Company, New York.

MTPR-11: Thermal Instabilities and Methods   Credits: 4

Mechanism of instability, various types of convection instabilities; Rayleigh-Benard convection, oberbeck convection, magnetoconvection, Marangoni convection, magneto-Marangoni convection, magnetic fluid convection, electroconvection, double diffusive convection, cross diffusion convection, biconvection. Boundary conditions.
Techniques to solve linear and nonlinear instability problems; Galerkin technique, perturbation techniques involving regular and singular perturbations, truncated representation of Fourier series (finite amplitude technique), numerical techniques, moment method, energy method, power integral technique, spectral method.

Suggested Readings:
1. D.A. Nield, A. Bejan, 2006, Convection in Porous Medium, Springer.
2. I.S. Shivakumara , M. Venkatachalappa, 2004, Advances in Fluid Mechanics, Vol 4, Tata McGraw-Hill.

MTPR-12: Advanced Numerical Analysis   Credits: 4

(Course comprises of 60% theory and 40% practicals)
Nonlinear functions of several variables, Nonlinear systems: Newtons method, Secant method. System of ordinary differential equations: system of two ordinary differential

equation, eulers method for systems, Runge-kutta methods for systems, Multi step methods for systems, second order ordinary differential equation. Stiffness of ordinary differential equation: Backward Euler methods, Implicit Runge-kutta methods. Stability for ordinary differential equation: A-stable and stiffly stable methods, stability in the limit. Finite difference method for solving nonlinear second order differential equation. Singular perturbation problems: introduction, asymptotic behaviour, linear problem, non-linear problem, problem with two boundary layers.

Practicals: Practicals on numerical computation of the problems based on the above methods using a programming language or software.

Suggested Readings:
1. Laurene V. Fausett, 2009, Applied Numerical Analysis Using MATLAB, 2nd Edition, Pearson.
2. M.K.Jain, 2003, Numerical Solution of Differential Equation, New Age Publ.
3. Adelaida B. Vasil'eva, Valentin F. Butuzov, Lenoid V. Kalachev, 1995, The Boundary Function Method for Singular Perturbation Problems, SIAM Studies in Applied Mathematics.

MTPR-13: Advanced Ring and Module Theory   Credits: 4

Jacobson radical, nilpotent elements, nil idea, nil radical, prime radical.
Semi-simple rings and modules, lifting of idempotent elements.
Minimal prime ideal, primary ring, quasi regular and regular elements, regular rings and their properties.
Local rings.
Exact and split sequences.
Essential and small submodules.
Injective and projective modules.

Suggested Readings:
1. D.M. Burton, 1970, A First Course in Rings and Ideals, Addison-Wesley
2. J. Lambek, 1966, Lectures on Rings and Modules, Blaisdell Publishing
3. Vivek Sahai and Vikas Bist, 2003, Algebra, Narosa Publ. House

MTPR-14: Calculus in Banach Spaces   Credits: 4

Derivatives in Banach Spaces, Basic properties of the derivatives, The gradients and differentials and their properties, Directional derivatives in Banach Spaces, Mean value theorem in Banach Spaces, Higher derivative and Leibnitz rule in Banach Spaces, The Taylor's theorem and the inverse function theorem and the implicit function theorem. Euler's theorem, Some other non – smooth derivatives: subgradient etc., Application of Calculus in linear and non–linear problems.

Suggested Readings:
1. Kalyan Mukherjee, Differential Calculas in Normed Linear Spaces,
2. J.M. Ortegard, W.C. Rhgeimbaldt, Iterative Solution of Non–linear Equations in Several Variables.

MTPR-15: Optimization and Non-Smooth Analysis   Credits: 4

The course will broadly comprise of Generalized gradients, relation to derivatives and subderivatives, properties, generalized gradients of integral functionals, problems from resource economics, normality and controllability, the multiplier rules for inequality problems, Lagrange multipliers, the value functions, sets which are lipschitz epigraphs.

Suggested Readings:
1. F.H. Clarke, 1990 , Optimization and Nonsmooth Analysis, SIAM, Classics in Applied Mathematics

MTPR-16: Operator Theory   Credits: 4

Operators on Hilbert Spaces: Elementary properties and examples, adjoint of an operator, projection and idempotents, invariant and reducing subspaces, compact operators, diagonalisation of compact self-adjoint operators, the spectral theorem and functional calculus for compact normal operators, unitary equivalence for compact normal operators.

Operators on Banach Spaces: Adjoint of a linear operator, the Banach-Stone theorem, compact operators and weakly compact operators, invariant subspaces.
The general theory of unbounded operators on Hilbert Space.

Suggested Readings:
1. John B. Conway, A Course in Functional Analysis, Springer-Verlag.
2. E. Kresyzig, Introductory Functional Analysis, Wiley International.
3. C.D. Aliprantis, 2002, An Invitation to Operator Theory, American Mathematical Society.
4. B.V. Limaye, 2001, Functional Analysis, New Age International.

MTPR-17: Banach Algebra   Credits: 4

Definition and elementary properties of Banach algebras, Ideal and quotients, topological divisor of zero, the spectrum, Riesz functional calculus, dependence of spectrum on the algebra, spectral theory of compact linear operators, abelian Banach algebras, the group algebra of a locally compact abelian group, general theory of C^*-algebras including the Gelfand-Naimark theorem.

Suggested Readings:
1. C.E. Rickert, Banach Algebras.
2. G.J. Murphy, C^*-algebras and Operator Theory, Academic Press.
3. Loomis, Abstract Harmonic Analysis, Academic Press.
4. W.V. Arveson, An Invitation to C^*-algebras, Springer-Verlag.

MTPR-18: Summability Theory   Credits: 4

Special methods of summation: Nörlund means, Regularity and consistency of Nörlund means, Inclusion, Equivalence, Euler means, Regularity of (E,1) method, , Abelian means, Regularity of (A, λ) method, A-method and its regularity, A Theorem of inclusion for Abelian means, Complex methods, Summability of 1-1+1-... by special Abelian Methods, A theorem of consistency, Methods ineffective for the seris 1-1+1-... , Riesz's Typical means.
Arithmetic means: Hölder's means, Simple theorems concerning Hölder Summability, Cesàro means, Simple theorems concerning Cesàro summability, Cesàro and Abel summability, Cesàro means as Nörlund means, Equivalence Theorem, Reisz's arithmetic means, Uniformly distributed sequence, Tauberian theorems for Cesàro summability.
The Methods of Euler and Borel: The (E,q) method, Simple properties of the (E,q) method, The formal relation between Euler's and Borel's methods, Borel's Methods, Normal, absolute and regular summability, Abelian Theorems for Borel's summability.

Suggested Readings:
1. A. Zygmund, Trigomometric Series Vol.1&2, Cambridge University Presss.

2. Hardy G. H, Divergent Series, Oxford Clarendon Press.
3. Javier Duoandikoetxea, Fourier Analysis, American Mathematical Society.

MTPR-19: Approximation of Functions by Summability Operators   Credits: 4

General Theorems:
Generalization concerning linear transformations, Regular transformations, Necessary and sufficient conditions for regularity, Variants and analogues, positive transformations, Definition of $(\overline{N}, p_n)$ method, regularity of $(\overline{N}, p_n)$ method, Example of a series which is $(\overline{N}, 1)$ i.e. $(C, 1)$ summability but not $(\overline{N}, 2^n)$ summable, Effectiveness of $\left(N, \frac{1}{n+1}\right)$ than the $(C, 1)$ means, Dilution of Series.

Trigonometric Series and Fourier series:
Trigonometric series, summation by parts, Orthogonal series, The trigonometric system, Fourier-Stieltjes series, completeness of the trigonometric system, Inequalities, Hölder's inequalities,

Fourier coefficients: Formal operators on S(f), Differentiation and integration of S(f), Formulae for partial sums of S(f) and $\overline{S}$ (f), summation of numerical series, General remarks about the summability of S(f) and $\overline{S}$ (f) , summability of S(f) and $\overline{S}$ (f) by the method of the first arithmetic mean, Abel's summability of S(f) and $\overline{S}$ (f).

Class of Functions:
The class L^2 , Functions of Lipα, Lip(α, r), Lip(ξ(t),r) classes, functions of almost Lipschitz class and generalized Lipschitz class.
Degree of Approximations: Approximation to functions by trigonometric polynomials, Best approximation, Properties of degree of approximation, Integral modulus of continuity of a function, Using matrix summability operators to approximate functions of generalized Lipschitz class by trigonometric polynomials.

Suggested Readings:
1. A. Zygmund, Trigonometric Series Vol.1& 2, Cambridge University Press.
2. G. H. Hardy, Divergent Series, Oxfod Clarendon Press.
3. N. K. Bari, Trigonometric Series, Fizmatgiz, Moskva.
4. P. L. Butzer and R. J. Nessel, Fourier Analysis and Approximation, Birkhaauser Verlag, Basel.

MTPR-20: Concept of Epidemiology and its Applications   Credits: 4

Introduction to infectious diseases, simple epidemic models; SIS, SIR, SIRS, SEIS, MSEIR, rate of immigration, contact rate, types of interactions, types of transmission, basic reproduction number (definition and its calculation), endemic situation.
Models for spread of infeghhgctious diseases; effect of ecological factors, role of carrier and bacteria on infectious diseases.
Models involving control measures; effect of media on epidemic outbreaks, vaccination models, chemical control for bacteria and carriers.

Suggested Readings:
1. J.N. Kapur, Mathematical Models in Biology and Medicine, East-West Press Pvt. Ltd.
2. Fred Brauer and Carlos Castillo-Chavez, Mathematical Models in Population Biology and Epidemiology, Springer.

3. R.S. Bhopal, Concepts of Epidemiology: An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology, Oxford University Press.

Molecular & Human Genetics

(Department of Molecular & Human Genetics)

Preamble

Research scholars of Department of Molecular & Human Genetics have to undergo a Ph.D. course work of 20 credits to be completed in 2 semesters. The course comprises of three components, the Faculty Level Common Course (3 credits), Discipline-Specific courses (7 credits) and Research Theme-Specific Courses (10 credits). The Discipline-Specific Courses comprise two theory papers and one laboratory–based course. The Research theme specific Courses have been prepared to offer choices to the research scholars. The Research theme specific courses comprise of 5 Elective courses of 3 credits each and compulsory courses (Preparation and Presentation of the Research Plan Proposal: 2 Credits and Review of Literature and Presentation of a seminar on a research-theme related topic: 2 Credits) of total 4 credits. A research scholar shall choose two Elective courses out of 5 Elective courses mentioned in the syllabus as suggested by the concerned RPC to earn 6 credits and the compulsory course to earn 4 credits. The details of Ph.D. course work are given below.

OUTLINE

Course Code	Title	Credits
	Discipline-Specific Course	**7**
MGPC-01	Techniques in Molecular Biology - Theory	3
MGPC-02	Techniques in Molecular Biology - Practical	1
MGPC-03	Fundamentals of Molecular Biology	3
	Research Theme-Specific Courses:	**10**
	Theory papers [Any 2 papers out of the following 5 papers]:	
MGPR-01	Developmental Genetics	6
MGPR-02	Reproductive Genetics	
MGPR-03	Immunogenetics	
MGPR-04	Cancer Genetics	
MGPR-05	Techniques in *Drosophila* Genetics	
MGPR-06	Preparation and presentation of the Research Plan Proposal	2
MGPR-07	Review of literature and presentation of a seminar on a research-theme related topic	2

COURSE CONTENTS

MGPC-01: Techniques in Molecular Biology - Theory   Credits: 3

1   Principles and applications of the following microscopy techniques   4

   1.1 Light Microscopy
   1.2 Phase-contrast Microscopy
   1.3 Fluorescence Microscopy
   1.4 Confocal Microscopy

2   Introduction to recombinant DNA technology   8

   2.1 Restriction and other enzymes used in recombinant DNA technology
   2.2 Cloning vectors

2.3 Transformation

3	Construction of genomic and cDNA libraries	2
4	Screening and characterization of clones	10

4.1 Preparation of probes
4.2 Principles of hybridization based techniques: colony, Southern, Northern and in situ hybridizations
4.3 Western blotting, immunoprecipitation, ELISA
4.4 Expression based screening
4.5 Interaction based screening: yeast two-hybrid system

5	Basic principles and applications of the following techniques	4

5.1 DNA sequencing
5.2 Polymerase Chain Reaction
5.3 Microarray
5.4 Mass-spectrometry

6	Promoter characterization	5

6.1 Promoter analysis through reporter genes
6.2 Electrophoretic mobility shift assay
6.3 DNA foot-printing

7	Mutagenesis	3

7.1. Site directed mutagenesis
7.2. Transposon mutagenesis
7.3. Construction of knock-out mutants

8	Gene transfer techniques	3

8.1 Transfection of cells: Principles and methods
8.2 Germ line transformation in *Drosophila* and transgenic mice: Strategies and methods

Suggested Readings:
1. Ausubel, 2002, Short Protocols in Molecular Biology. Wiley
2. Brown, 2000, Essential Molecular Biology VI. AP
3. Brown, 2000, Essential Molecular Biology VII. AP
4. Brown, 2006, Gene Cloning and DNA Analysis - An Introduction. Blackwell
5. Glick and Pasternak, 2003, Molecular Biotechnology. ASM Press
6. Kracher, Molecular Biology - A Practical Approach.
7. Krenzer and Massey, 2000, Recombinant DNA and Biotechnology. ASM
8. Micklos and Freyer, 1990, DNA Science. CSHL
9. Primrose, 2001, Molecular Biotechnology. Panima
10. Robertson, 1997, Manipulation & Expression of Recombinant DNA. AP
11. Sambrook, 2001, Molecular Cloning. CSHL
12. Twyman, 1999, Advanced Molecular Biology. Viva
13. Watson, 1992, Recombinant DNA. Freeman
14. Primrose and Twyman, 2006, Principles of Gene Manipulation and Genomics. Blackwell

MGPC-02: Techniques in Molecular Biology - Practical   Credit: 1

MGPC-03: Fundamentals of Molecular Biology (Theory Paper)   Credits: 3

1	Nucleic acids	8

1.1 Base composition, structure and conformation
1.2 Nucleic acid chemistry: Denaturation, hybrids, nonenzymatic transformation, methylation.
1.3 Nucleosome &higher level organization

Suggested Readings:

1. Alberts, 1999, The Science of Genetics. Saunders
2. Benjamin, 2003, Genetics: A Conceptual Approach. Freeman
3. Berg and Singer, 1998, Genes and Genome.
4. Black, 2002, Microbiology: Principles and Explorations. Wiley
5. Dale & Schartz, 2003, From genes to Genome. Wiley & Sons
6. Griffiths, 2002, Modern Genetic Analysis. Freeman
7. Griffiths, 2004, An Introduction to Genetic Analysis. Freeman
8. Hartl, 2002, Essential Genetics. Wiley & Sons
9. Klug & Cummings, 2003, Essentials of Genetics. Prentice Hall
10. Latchman, 1995. Gene Regulation. Chapman & Hall
11. Lewin, 2007, Genes IX. Pearson
12. Maloy and Freifelder, 1994, Microbial Genetics. Jones and Barlett
13. Meesfeld, 1999, Applied Molecular Genetics. Wiley-Liss
14. Russell, 2002, Genetics. Benjamin
15. Streips & Yasbin, 2002, Modern Microbial Genetics. Wiley
16. Trun & Trempy, 2004, Fundamentals of Bacterial Genetics. Blackwell
17. Watson, 2004, Molecular Biology of the Gene. Pearson

MGPR-01: Developmental Genetics   Credits: 3

1   Early development

    1.1 Fertilization
    1.2 Types of cleavage
    1.3 Gastrulation
    1.4 Concept of determination, competence and differentiation

2   Development of vertebrate nervous system

    2.1 Formation of neural tube
    2.2 Formation of brain regions
    2.3 Tissue architecture of the central nervous system

3   3.1 *Caenorhabditis*: Vulva formation

    3.2 *Drosophila*

        3.2.1 Maternal genes and formation of body axes
        3.2.2 Segmentation genes
        3.2.3 Homeotic genes function
        3.2.4 Imaginal disc development

    3.3 Vertebrates

        3.3.1 Axes formation and HOX genes
        3.3.2 limb formation in chick

4   Genetic determination of sex in *Caenorhabditis*, *Drosophila* and mammals

5   Regeneration

6   Senescence

7   Embryonic stem cells and their applications

8   Clinical embryology

    8.1 Stages of human embryonic development
    8.2 Congenital malformations and teratogenesis
    8.3 Reproductive failure and infertility and assisted reproduction

Suggested Reading
1   Alberts, 2007, Molecular Biology of The Cell. Garland
2   Gilbert, 2006, Developmental Biology. Sinauer
3   Kalthoff, 1996, Analysis of Biological Development. McGraw Hill
4   Lewin, 2007, GenesIX. Pearson
5   Monk, 1987, Mammalian Development – A Practical Approach. IRL
6   O'Rahilly and Muller, 1992, Human Embryology and Teratology. Wiley
7   Rana, 1998, Human Embryology Made Easy. Harwood
8   Wolpert, 2007, Principles of Development. Oxford

MGPR-02: Reproductive Genetics   Credits: 3

1   Male and female reproductive systems
    1.1 Gonads and differentiation of sexual character
    1.2 Hormonal regulation of sexual differentiation

2   Reproductive disorders

    2.1 Pseudohermaphroditism
    2.2 Truehermaphroditism
    2.3 Gonadaldysgenesis
    2.4 Anomalies of genital ducts

3   Infertility
    3.1 Genetic basis of male infertility
    3.2 Genetic basis of female infertility
    3.3 Recurrent pregnancy loss

4   Technologies in reproductive assistance

5   Legal and ethical implications in reproductive assistance

Suggested reading:
1 Besser & Thorner, 2002, Comprehensive clinical endocrinology. Mosby
2 Rimoin, 2002, Principles & Practice of Medical Genetics, Vol I-III. Churchill

MGPR-03: Immunogenetics   Credits: 3

1   An introduction to immune system
    1.1 Innate and adaptive immunity
    1.2 Cells and organs of the immune system
    1.3 Primary and secondary immune responses
    1.4 Antigens, antibodies and T cell receptors

      1.4.1 Antigens
      1.4.2 Structure and function of immunoglobulins
      1.4.3 Monoclonal antibodies
      1.4.4 B and T cell receptors and coreceptors
      1.4.5 Antigen-antibody interactions

2   Immunoglobulin and T-cell receptor genes
    2.1 Organization of Ig gene loci
    2.2 Molecular mechanisms of generation of antibody diversity
    2.3 Expression of Ig genes
    2.4 Regulation of Ig gene transcription
    2.5 Antibody engineering
    2.6 Organization of TCR gene loci
    2.7 Generation of TCR diversity

3   The HLA complex
    3.1 Organization of HLA complex
    3.2 Structure of class I and II HLA molecules
    3.3 Expression of HLA genes
    3.4 HLA polymorphism

4   Generation and regulation of immune responses
    4.1 Antigen processing and presentation
    4.2 MHC-restriction
    4.3 Cytokines
    4.4 T Cell Maturation, activation and differentiation
    4.5 B Cell Generation, Activation and differentiation
    4.6 Clonal selection and immunological memory
    4.7 Complement system
    4.8 Leukocyte, Activation and Migration
    4.9 Cell mediated cytotoxic responses
    4.10 Regulation of immune responses

           4.11 Immunological tolerance

5   Disorders of Human Immune System
      5.1 Primary and secondary immunodeficiencies
      5.2 Autoimmune disorders
      5.3 Hypersensitive reactions
      5.4 Cytokine-related diseases

6   Immune system in human health
      6.1 Immune response to infectious diseases and malignancy
      6.2 Concept of immunotherapy
      6.3 Vaccines
      6.4 Transplantation immunology

Suggested reading

1   Abbas, 2007, Cellular and Molecular Immunology. Saunders
2   Benjamin, 2003, Immunology – A Short Course. Wiley-Liss
3   Kuby, 2006, Immunology. Freeman
4   Roitt, 2003, Essential Immunology. Blackwell
5   Roitt, 2001, Immunology. Mosloy

MGPR-04: Cancer Genetics   Credits: 3

1.   Cell transformation and tumourigenesis
1.1. Cell cycle check point and cancer
1.2   Oncogenes
1.3. Tumour suppressor genes
1.4. DNA repair genes and genetic instability
1.5. Epigenetic modifications
1.6   Telomerase activity
1.7   Centrosome malfunction
1.8. Genetic heterogeneity and clonal evolution

2. Familial cancers: Retinoblastoma, Wilms' tumour, Li-Fraumeni syndrome, colorectal, cancer, breast cancer
3. Genetic predisposition to sporadic cancer
4. Tumour progression: angiogenesis and metastasis
5. Tumour specific markers
6. Cancer and environment: physical, chemical and biological carcinogens

Suggested Readings:
1.   Alberts, 2008, Molecular Biology of the Cell. Garland
2.   Benjamin, 2003, Genetics: A Conceptual Approach. Freeman
3.   Berg and Singer, 1998, Genes and Genome.
4.   Black, 2002, Microbiology: Principles and Explorations. Wiley
5.   Cowell, 2001, Molecular Genetics of Cancer. Bios
6.   Dale & Schartz, 2003, From genes to Genome. Wiley & Sons
7.   Ehrlich, 2000, DNA Alterations in Cancer. Eaton
8.   Gersen & Keagle, 1999, Principles of Clinical Cytogenetics. Humana
9.   Griffiths, 2002, Modern Genetic Analysis. Freeman
10. Griffiths, 2004, An Introduction to Genetic Analysis. Freeman
11. Hartl, 2002, Essential Genetics. Wiley & Sons
12. Klug & Cummings, 2003, Essentials of Genetics. Prentice Hall
13. Latchman, 1995, Gene Regulation. Chapman & Hall
14. Lewin, 2010, GenesX. Pearson
15. Lodish, 2004, Molecular Cell Biology. Freeman
16. Meesfeld, 1999, Applied Molecular Genetics. Wiley-Liss
17. Russell, 2002, Genetics. Benjamin
18. Stillman, 1994, Molecular Genetics of Cancer. CSHL

MGPR-05: Techniques in *Drosophila* Genetics   Credits: 3

1. Life cycle and advantages of *Drosophila* as a model genetic system
     1.1   Embryonic development
     1.2   Larval stages and tissue types
     1.3   Pupa and metamorphosis
     1.4   Adult morphology and internal organs
     1.5   Spermatogenesis and oogenesis
2. Nomenclature of gene mutations and chromosome rearrangements, balancer chromosomes
3. Linkage and crossing over
     3.1 Genetic recombination and construction of genetic maps in *Drosophila*
4. Polytene chromosomes: maps, puffing and utility
5. Imaginal discs: development and differentiation
6. Mutagenesis
     6.1   X-ray and chemical mutagenesis.
     6.2   P-element insertion mutagenesis
7. Germline transformation with P-element based vector
8. Mitotic recombination and generation of somatic clones for developmental studies
9. Conditional and/or targeted expression or downregulation of genes
10. *Drosophila* models for human genetic disorders
11. Bioinformatics and Web resources for *Drosophila* geneticists

Suggested Readings:
1. Ashburner, 1989, Drosophila – A laboratory Handbook. CSHL
2. Bates and Arias, 1993, Development of Drosophila melanogaster (Vol I & Vol II). CSHL
3. Goldstein and Fyrberg, D. melanogaster, 1994, Practical uses in cell and molecular biology. Academic
4. Lawrence, 1992, The making of a fly: The genetics and animal design. Blackwell

MGPR-06: Preparation and presentation of the Research Plan Proposal   Credits: 2

MGPR-07: Review of literature and presentation of a seminar on a research-theme related topic   Credits: 2

Evaluation:
- Submission of the write up for evaluation by the RPC and Oral presentation before the RPC. The RPC will approve and evaluate the Research Plan Proposal.

- The RPC will approve the seminar topic and evaluate.

PHYSICS

(Department of Physics)

Preamble

Each student has to study a common course of 3 credits offered at the Faculty level, two discipline-specific courses of 7 credits, two RPC based courses of 3 credits each from the Research Theme Specific Courses. It is to be noted that a student has to study both the courses of his/her area of research, for example, PHPR -03 and PHPR -04 or PHPR-13 and PHPR-14 or PHPR-15 and PHPR-16.

Each student has to make a survey of research work done in his/her field and submit a review report and give a seminar on A topic allotted by the RPC. The student shall also be required to prepare and present the research plan proposal.

OUTLINE

Discipline-Specific–Courses   Credits: 7

Course Code	Title	Credits
PHPC-01	Research Methodology: Theoretical Techniques Based Course	4
PHPC-02	Research Methodology: Experimental Techniques Based Course	3

Research Theme Specific-Courses   Credits: 10

Any **TWO PAPERS** out of the followings (PHPR-01 to PHPR-08) to be opted by a research scholar		
PHPR-01	Structural and Microstructural Characterization of Materials	3
PHPR-02	Synthesis and Physical Property Measurement Techniques of Materials	3
PHPR-03	Condensed Matter Theory-I	3
PHPR-04	Condensed Matter Theory- II	3
PHPR-05	Experimental Spectroscopy – I	3
PHPR-06	Experimental Spectroscopy – II	3
PHPR-07	Theoretical Spectroscopy – I	3
PHPR-08	Theoretical Spectroscopy – II	3
PHPR-09	Emerging Electronic, Ionic and Magnetic Materials-I	3
PHPR-10	Emerging Electronic, Ionic and Magnetic Materials-II	3
PHPR-11	Computational Methods in Electronics-I	3
PHPR-12	Computational Methods in Electronics-II	3
PHPR-13	Theoretical Nuclear Physics	3
PHPR-14	Experimental Nuclear Physics	3
PHPR-15	Theoretical High Energy Physics	3
PHPR-16	Experimental High Energy Physics	3
Compulsory for all the research scholars		
PHPR-17	Preparation and Presentation of the Research Plan Proposal	2
PHPR-18	Review, Report and Seminar on a Topic Allotted by R.P.C.	2

PHPC-01: Research Methodology: Theoretical Techniques Based Course Credits: 4

Classical Mechanics:
Lagrangian and Hamiltonian methods, small oscillations, Hamilton -Jacobi theory, rigid body motion, rotation matrices, relativistic kinematics

Quantum Mechanics:
Schrodinger wave equation, operator methods, symmetry and angular momentum. approximate methods, quantum mechanics for a system of particles, Dirac equation.

Electrodynamics:
Maxwells equations, potential formulation, energy and momentum, electromagnetic waves and radiation

Statistical Physics:
Ensemble theory, partition function, quantum statistics, Bose einstein condensation, quantum fluids, superconductivity. Non equilibrium statistical mechanics, renormalization group theory, Kinetics of phase transitions.

Computational Physics:
Matrix diagonalization, numerical integration, solving differential equation, Euler, Runge –Kutta and Verlet schemes. Monte-Carlo and molecular dynamics methods and algorithms.

Suggested Readings:
1. H. Goldstein, 1965, Classical Mechanics. Addison-Wesley.
2. H. Goldstein, C.P. Poole, J.L. Safko, 2001, Classical Mechanics. Addison-Wesley.
3. D.J. Griffiths, 2001, Introduction to Quantum Mechanics. Springer Link.
4. L.H. Ryder, 1996, Quantum Field Theory. Camb. Univ. Press.
5. R.K. Patharia, Statistical Mechanics.
6. L.E. Reichl, 1998: A Modern Course in Statistical Physics. John Wiley & Sons.
7. Landau & Lifshitz, 1980, Classical Theory of Fields. Butterworth-Heinermann.

PHPC-02: Research Methodology: Experimental Techniques Based Course
Credits: 3

Vacuum Techniques:
Simple description and working principle of vacuum pumps (Rotary, Diffusion and Turbo-molecular), Penning and Pirani gauges, leak detection techniques.

Structural Characterization and Imaging Techniques:
X-ray diffraction ((XRD), electron and neutron diffraction, elementary ideas of photoelectron spectroscopy (PES), basic principal of atomic resolution electron microscopy, scanning electron microscopy (SEM), scanning tunneling and atomic force microscopy (STM, AFM) techniques.

Optical Characterization and Spectroscopic Techniques:
Infrared and ultraviolet / visible (IR, UV/Vis) absorption spectroscopy, Raman and Fluorescence spectroscopy, elementary idea of laser-based non-linear techniques.

Accelerator-based Techniques:
Accelerators, Rutherford back scattering (RBS), particle induced x-ray emission (PIXE) and particle induced g-ray emission (PIGE).

Physical Property Measurements:
Intensive and extensive properties, physical property measurements (DSC, DTA, TGA,), transport properties (R-T, I-V), low conductivity measurement (Dielectric Spectroscopy), magnetic properties of bulk and nano phases of material (VSM & SQUID).   .

Detection Techniques:
Particle and radiation interaction with material, detectors: thermal, photon and electron detectors, Soild State and scintillation detectors, multi-channel analyzers (MCA).

Suggested Readings:
1. J.M. Hollas, 1986, Modern Spectroscopy. John Wiley & Sons.
2. G.M. Barrow, 1984, Introduction to Molecular Spectroscopy. McGraw-Hill Book Co.
3. Gareth Thomas, Michael J. Goringe, 1979, Transmission Electron Microscopy of Materials, John Wiley.
4. B. D. Cullity, 1978, Elements of X-ray Diffraction. Addison-Wesley.
5. M.T. Bray, Samuel H. Cohen, Marcia L. Lightbody, 1993, Atomic Force Microscopy/Scanning Tunneling Microscopy, Plenum Press.

PHPR-01: Structural and Microstructural Characterization of Materials Credits: 3

X-ray Diffraction:
Fundamental of material characterization using x-ray technique, intensity data collection, data reduction profile fitting and refinement (Lebail & Rictveld). Small angle x-ray scattering (SAXS) to study shape and size distributions.

Transmission Electron Microscopy:
Working principle of transmission electron microscope (TEM). High resolution electron microscope. Electron optics kinematical theory. Bright field and dark field imagings. Phase contrast and diffraction contrast. Indexing and analysis of selected area diffraction. Elementary idea of abervation from electron microscopy. Sample preparation for TEM (Jet polishing and Ion beam milling).

Scanning Electron Microscopy:
Basic of scanning electron microscopy (secondary electron and their detections). Evaluation of surface images from (SEM). Elemental analysis through energy dispersive x-ray analysis (EDX).

Suggested Readings:
1. B.D. Cullity, 1956, Elements of X-ray Diffraction. Addison-Wesley Publishing Company.
2. R.A. Young, 1996, The Rietveld Method: Edited by International Union of Crystallography, Oxford, New York.
3. Gareth Thomas, Michael John, A Wiley, 1987, Transmission Electron Microscopy of Materials: Interscience Publication. John Wiley & Sons.
4. J. Goldstein, D. Newbury, D. Joy, C. Lyman, P. Echlin, E. Lifshin, L. Sawyer, J. Michael, 2003, Scanning Electron Microscope and X-ray Microanalysis. Springer Science.
5. H. Singh Nalva, Vol. 02, 2004, Specification of Microstructure and Characterization by Scattering Techniques.

PHPR-02: Synthesis and Physical Property Measurement Techniques of Materials
Credits: 3

Synthesis:
Principal of radio frequency induction furnace, melt quenching method to produce glassy materials, elementary concepts of pulsed laser deposition, chemical vopour

deposition, miscel techniques, spray pyrolysis and colloidal technique to synthesis nano particles.

Physical Property Measurement (PPMS):
Its use to measure magnetic and transport properties such as AC & DC magnetization, classical and Quantam Hall coefficient, I-V characteristics, specific heat thermo power.

Thermal constant Analysis using transient plane source method and its application to measure various thermal properties (thermal conductivity and thermal diffusivity).

DSC & DTA: - Principal of DSC & DTA techniques in isothermal and non isothermal modes. Some applications in the study of solid state phase transition. Impedance analysis to determine dielectric properties of materials.

Suggested Readings:
1. P. Charles. Poole Jr., Frank J. Owens, 2007, Introduction to Nanotechnology, John Wiley & Sons (Asia) Pvt. Ltd.
2. J. Goldstein, D. Newbury, D.Joy, C.Lyman, P. Echlin, E.Lifshin, L.Sawyer, J. Michael, 1996, Different Scanning Calorimetry. Springer, Berlin, Heidelberg, New York.
3. Sulbha K. Kulkarni, 2007, Nanotechnology: Principles and Practices, Capital Publishing Company, New Delhi.

PHPR-03: Condensed Matter Theory-I   Credits: 3

Symmetry and Structures:
Density operator and its correlation functions, one-and two-dimensional order in 3D materials, liquids and liquid crystals, Incommensurate structures, magnetic order, fourier transforms.

Thermodynamics and Statistical Physics:
Basics of thermodynamics, review of statistical methods, spatial correlations in classical systems, ordered systems, symmetry and order parameters, functional derivatives.

Mean-Field Theory:
The ising and n-vector model, Landau theory, extension to first - order transitions, applications to magnetism, liquid crystals and multiferroics, variational mean- field theory, density functional theory and its applications to ordered systems.

Models and Methods for Polymeric Systems:
Continuous models, lattice models, renormalization group approach and its application to polymeric systems.

Suggested Readings:
1. P.M. Chaikin, T.C. Lubensky, 1998, Principle of Condensed Matter Physics. Cambridge University Press.
2. J.P. Hansen, I.R. McDonell, 2006, Theory of Simple Liquids. Elsevier Inc.
3. P.G. de Gennes, 1979, Scaling Concept in Polymer Physics. Cornell University Press.
4. J.D. Cloizeanx, G. Jannink, 1990, Polymer in Solutions: Their Modelling and Structure. Oxford University Press.
5. S. Singh, 2002, Liquid Crystals: Fundamentals. World Scientific.
6. G.D. Mahan, 1990, Many Particle Physics. Springer.
7. Nigel Goldennfeld, 1992, Lectures on Phase Transitions and the Renormalization Group. Addison Wesley.
8. S.Puri, V.K. Wadhawan, 2010, Kinetics of Phase Transitions. World Scientific.

PHPR-04: Condensed Matter Theory- II   Credits: 3

Field Theories, Critical Phenomena and Renormalization Group:
Breakdown to mean-field theory, mean-field transitions revisited, self-consistent field approximation, critical exponents, universality and scaling, Kadnoff construction, Momentum shell renormalization group.

Dynamics:
Correlation functions, response functions, applications to simple problems, Kinetics of phase transitions.

Green Function and its Applications to Superconductivity:
Introduction to green function, free fermi gas, calculation of density of states and other physical quantities, BCS theory of superconductivity.

Suggested Readings:
1. P.M. Chaikin and T.C. Lubensky, 1998, Principle of Condensed Matter Physics. Cambridge University Press.
2. J.P. Hansen and I.R. McDonell, 2006, Theory of Simple Liquids. Elsevier Inc.
3. P.G. de Gennes, 1979, Scaling Concept in Polymer Physics. Cornell University Press.
4. J.D. Cloizeanx and G. Jannink, 1990, Polymer in Solutions: Their Modelling and Structure. Oxford University Press.
5. S. Singh, 2002, Liquid Crystals: Fundamentals. World Scientific.
6. G.D. Mahan, 1990, Many Particle Physics. Springer.
7. Nigel Goldennfeld, 1992, Lectures on Phase Transitions and the Renormalization Group. Addison Wesley.
8. S.Puri and V.K. Wadhawan, 2010, Kinetics of Phase Transitions. World Scientific.

PHPR-05: Experimental Spectroscopy – I   Credits: 3

Spectroscopy of Atoms and Molecules:
Designation of Atomic and Molecular States, Electronic, vibrational and rotational spectra, concept of allowed and forbidden Transitions.

Vibrational Spectroscopy:
Principle of Fourier transform (FT) spectroscopy, FT-IR and FT- Raman spectrometers, advantages of Fourier transform technique over the conventional methods, fast Fourier transform (FFT), applications of IR and Raman spectroscopy, surface enhanced Raman spectroscopy (SERS) and its applications, Resonance Raman spectroscopy and CARS.

Spectroscopy of Special Materials:
Raman spectroscopy of crystalline and liquid crystalline materials, spectroscopic signatures of phase transition, UV /Vis absorption spectroscopy of nanomaterials, vibrational spectroscopy of molecules adsorbed on nano-colloids, UV/Vis absorption and flourescence spectroscopy of doped glasses.

Collision-Based Spectroscopic Techniques:
Collision cross section, inner shell excitation / Ionization, molecular beam spectroscopy.

Suggested Readings:
1. W. Demtroder, 2004, Laser Spectroscopy: Basic Concept and Instrumentation, Springer.
2. J. M. Hollas, 1998, High Resolution Spectroscopy. John Wiley & Sons.
3. J.M. Hollas, 1986, Modern Spectroscopy. John Wiley & Sons.
4. A. Thorpe, 1999, Spectrophysics. Springer.
5. B. Schrader, ed., 1993, Infrared and Raman Spectroscopy. John Wiley & Sons.

PHPR-06: Experimental Spectroscopy – II   Credits: 3

Electronic Spectroscopy:
Electronic spectra of linear molecules, classification of electronic states in polyatomic molecules and their spectra, vibrational analysis of diatomic and polyatomic molecules, dissociation energy and its determination.

Non-Conventional Spectroscopic Techniques:
Basic idea of circular dichroism, optogalvanic spectroscopy, principle and applications of photoacoustic spectroscopy, laser fluorescence and single vibronic level (SVL) spectroscopy, saturation spectroscopy, multiphoton spectroscopy, time-resolved spectroscopy and measurement of life time, time of flight mass spectroscopy and its applications, laser-Induced breakdown spectroscopy (LIBS).

Laser Cooling:
Laser cooling, spectroscopy of ultracold atoms and molecules, formation of Bose-Einstein condensate.

Suggested Readings:
1. W. Demtroder, 2004, Laser Spectroscopy: Basic Concept and Instrumentation, Springer.
2. J. M. Hollas, 1998, High Resolution Spectroscopy. John Wiley & Sons.
3. J.M. Hollas, 1986, Modern Spectroscopy. John Wiley & Sons.
4. A. Thorpe, 1999, Spectrophysics. Springer.
5. B. Schrader, ed., 1993, Infrared and Raman Spectroscopy. John Wiley & Sons.
6. S.N. Thakur, D.K.Rai, 2010, Atom Laser and Spectroscopy.PHI, Learning Pvt. N.D.

PHPR-07: Theoretical Spectroscopy – I   Credits: 3

Group Theory and its Application to Molecular Vibrations:
Symmetry operations and their matrix representations, reducible and irreducible representations, Great Orthogonality Theorem and its corollaries, character tables, irreduciable representations of C_{2v}, C_{3v} and D_2h point groups, normal modes of vibration and their distribution into symmetry species of point groups of molecules, infrared and Raman selection rules, overtone and combination bands, Normal coordinate analysis using Wilson's GF matrix method, G-matrix, force fields and F-matrix, Determination of consistent force fields for molecules of C_{2v}, C_{3v} and D_2h point groups.

Photorefractive Property of Materials:
Non-linear optical effects, Pockel's effect, electromagnetic wave propagation in periodic media – coupled mode theory, photorefractive effects- band transport model, space charge fields and their transient solutions, volume grating, wave mixing in photorefractive media – degenerate and non-degenerate two wave mixing, resonators and phase conjugators.

Suggested Readings:
1. F.A. Cotton, 1990, Chemical Applications of Group Theory. John Wiley & Sons.
2. E.P. Wigner, 1959, Group Theory and its Application to the Quantum Mechanics of Atomic Spectra, Academic Press
3. P. Yeh, 1993, Introduction to Photorefractive Non-linear Optics. Wiley & Sons.

PHPR-08: Theoretical Spectroscopy – II   Credits: 3

Electronic Structure Theory of Molecules:
Quantum theoretical methods, concepts of atomic and molecular orbitals, Hartree-Fock theory, semi-empirical molecular orbital methods, introductory details of ab-initio methods, density functional theory, Slater orbitals, Gaussian basis sets, application of molecular orbital theory to diatomic and polyatomic molecules, charge density distribution in molecules, dipole moment, molecular electrostatic potential, intermolecular interactions, energy partitioning into different types of interactions, Hellman-Feynman theorem and concept of force, hybrid atomic orbitals, lone pairs, conformations, calculation of electronic spectra of molecules, geometry optimization, chemical reactions, transition state theory, determination of excited state molecular geometry, molecular mechanical methods.

Properties of Biomolecules:
Stability and structures of nucleic acids and proteins, primary, secondary and tertiary protein structures, hydrogen bonding and stacking interactions, importance of electrostatic interactions, enzyme catalysis, biomolecular recognition, drug design, interaction of UV radiation with nucleic acids, photodynamic action.

Suggested Readings:
1. I.N. Levine, 1994, Quantum Chemistry, 4th Edition. Prentice-Hall of India, Pvt. Ltd.
2. W.J. Hehre, L.Radom, P.V.R. Schleyer, J.A. Pople, 1986, Ab Initio Molecular Orbital Theory. John Wiley, Wiley- Interscience.
3. A. Szabo, N.S. Ostlund, 1996, Modern Quantum Chemistry. Mc-Graw Hill.
4. R. McWeeny, 1979, Coulsons's Valence. Oxford University Press.
5. P. Narayan, 2000, Essentials of Biophysics. New Age International Publishers, New Delhi.

PHPR-09: Emerging Electronic, Ionic and Magnetic Materials – I   Credits: 3

Electronic Materials:
Crystalline semiconductors, compound semiconductors, interface properties, M-S interface and its relationship with semiconductor parameters, traps and defects in semiconductors. Organic semiconductors, photovoltaic devices. Material preparation by vacuum deposition and sputtering, substrate cleaning by glow discharge by low pressure. Experimental methods for characterizing semiconductors: (I-V, C-V, optical absorption and band gap).

Ionic and Polymeric Materials:
Basics of ion conduction in solids, superionic solids/solid electrolytes, crystalline, gel, polymer and glassy solid electrolytes, polymer-ceramic nanocomposites and bio-polymers. Types of ion conducting polymers. Polymer complexes with salt/acid/fillers/plasticizers. Method of preparation of polymeric films.

Magnetic Materials:
Magnetic materials and layered magnetism, half metals, DMS, spontaneous magnetization, GMR materials and measurements of magnetic susceptibility by vibration magnetometer, SQUID, spin-polarized transport, magnetism of nano-phase magnetic materials, MFM/AFM.

Suggested Readings:
1. S.M. Sze, 2003, Semiconductor Devices Physics and Technology. John Wiley & Sons, Inc.
2. K.L. Chopra, 2008, Thin Film Phenomenon. Krieger Publishing Co.
3. F.M. Grey, 1991, Solid Polymer Electrolytes - Fundamentals and Technological Application. VCH Publishers, Inc.

4. Farzad Nasipouri, Alain Nogaret 2010, Nanomagnetsim and Spintronics: Fabrication, Materials, Characteization and Applications. World Scientific.

PHPR-10: Emerging Electronic, Ionic and Magnetic Materials – II   Credits: 3

Ionic and Conducting Polymeric Materials, Characterization and Applications:
Simple models for ionic conduction, dielectric relaxation (α, β, γ) in ionic materials, polarisation, complex permittivity and loss factor, frequency and temperature dependence of dielectric parameters, scaling of frequency dependent conductivity (Jonschers law).Viscoelastic relaxation. Electrodeposition. Solid state ionic devices with special reference to fuel cells, dye sensitized solar cell, batteries, supercapacitors and electrochromic display devices, ionic liquids and ionogels. Experimental methods for characterizing solid electrolytes, impedence spectroscopy, cyclic voltametry. Ion dynamics by dielectric relaxation and NMR, ionic transference number and mobility measurement, optical properties and determination of band gap, thermal characterization of ionic materials.

Semiconductor ceramics, method of preparation of ceramics (solid-state and sol-gel route) use of ceramics as temperature sensors. Electroactive polymers, organic semiconductor, organic semiconductor electronic devices, nanoelectronics.

Suggested Readings:
1. S.M. Sze, 2003, Semiconductor Devices Physics and Technology. John Wiley & Sons, Inc.
2. K.L. Chopra, 2008, Thin Film Phenomenon. Krieger Publishing Co.
3. F.M. Grey, 1991, Solid Polymer Electrolytes - Fundamentals and Technological Application. VCH Publishers, Inc.
4. C. Pratt, Application of Conducting Polymers
5. J. Przyluski and S. Roth, 1993, Conducting Polymers-Transport Phenomena, Trans. Tech. Pub.

PHPR-11:   Computational Methods in Electronics – I   Credits: 3

Data Acquisition Fundamentals:
Introduction to signal and system, signal conditioning, sampling, digitization and data acquisition. DAQ hardware and software perspectives with respect to applications.

Digital Signal Processing and Application Algorithms:
Continuous and discrete integral transforms, discrete Fourier transform, Laplace transform, Z-transform, Hilbert transform, wavelets and wavelet transform, convolution and correlation, autocorrelation, crosscorrelation, power spectral analysis, discrete wavelet decomposition and transient analysis, digital filtering, window function method, denoising, Kalman filtering.

Problem Solving in MATLAB
1. Digital filter design
2. Time-series analysis by FFT
3. Transient analysis by wavelet decomposition

 Suggested Readings:
1. A. Bateman, I. P. Stephens, 2002, The DSP Handbook— Algorithms, Applications and Design Techniques. Prentice-Hall.
2. E. O. Brigham, 1988, The Fast Fourier Transform and Its Applications. Prentice-Hall.
3. J. G. Proakis, D. G. Manolakis, 2004, Digital Signal Processing. Pearson.
4. C. S. Burrus, R. A. Gopinath, H. Guo, 1998, Introduction to Wavelets and Wavelet Transforms. Prentice-Hall.

PHPR-12:   Computational Methods in Electronics – II   Credits: 3

Data Analysis Methods:
Multivariate statistical analysis, averaging, smoothing, parametric and nonparametric data modeling and estimation, principal component analysis, genetic algorithm, and some examples of specific applications.

System Modeling and Solution Methods:
Linear and nonlinear oscillators, equations of motion, fixed points, linear stability analysis, bifurcation and chaos.

Modal propagation in waveguides and periodic media, coupled wave analysis by matrix method, finite element method.

Problem Solving in MATLAB:
1. Principal component analysis
2. Wave propagation in multilayer structures
3. Finite element method

Suggested Readings:
1. T. W. Anderson, 2003, An Introduction to Multivariate Statistical Analysis. Wiley.
2. M. Lakshmanan, S. Rajasekar, 2003, Nonlinear Dynamics— Integrability, Chaos and Patterns. Springer.
3. M.S. Gockenbach, 2006, Understanding and Implementing the Finite Element Methods. SIAM.
4. P. Yeh, 2005, Optical Wave in Layered Media. Wiley.

PHPR-13: Theoretical Nuclear Physics   Credits: 3

General Properties of Nuclei:
Parametrisation of nuclear masses (Weizsaecker formula), Properties of nuclear matter, Nuclear stability, Alpha, beta and gamma decays with selection rules, Particle emissions, Nuclear fission and fusion processes, Production of nuclear energy and working of a reactor, General nature of nuclear force between nucleons.

Nuclear Structure and Reactions:
Fermi gas model, Shell model, Collective rotational and vibrational models of nuclei, Microscopic description of nuclei using Hartree-Fock theory, Description of simple 1particle-1hole excited states using the Tamm-Dancoff and Random Phase approximations (TDA and RPA),
General feature of nuclear reactions, nuclear spectroscopy using stripping and pick up reactions, Heavy-ion reactions, Population of high spin states, Backbending phenomenon.

Quarks and Leptons and their Interactions, Structure of Nucleon:
Lepton and quark families, Different types of interactions, Neutrino interaction with matter, Steller neutrinos, Neutrino telescopes, Quark structure of nucleons: Electron-proton scattering, Bjorken scaling and the Parton model.

Nuclear Astrophysics:
Abundance of the elements in the solar system, Nucleo-synthesis, r-, s- and p-processes, Neutron resonant and non-resonant reactions, Hydrogen burning, Helium burning and production of carbon and oxygen, Production of heavy elements, Steller stability.

Suggested Readings:
1. M. A. Preston, R. K. Bhaduri, 1982, Structure of the Nucleus. Addison-Wesley.

2. M. K. Pal, 1982, Theory of Nuclear Structure. East-West Press.
3. W. E. Burcham, M. Jobes, 1998, Nuclear and Particle Physics. Addison-Wesley.
4. B. Povh, K. Rith, C. Scholz, F. Zetsche, 1995, Particles and Nuclei. Springer.
5. Rolfs, Rodney, Cauldrons in Cosmos - Nuclear Astrophysics. Chicago University Press.

PHPR-14: Experimental Nuclear Physics   Credits: 3

Nuclear Techniques and Applications:
Particle Induced X-ray Emission (PIXE), Rutherford Back Scattering (RBS), Neutron Activation Analysis (NAA) and their applications, Gamma-ray Spectroscopy: Energy, Intensity, Angular correlation and Coincidence measurements, development of nuclear level scheme, Lifetime measurements using Doppler Shift Attenuation and Plunger techniques, Charged particles spectroscopy, Time of flight (ToF) technique, Positron Annihilation and Mossbauer Spectroscopy.

Instrumentation:
Production of beam of charged particles using Linear Accelerator and Tandetron Accelerator; Production of neutron using accelerator, Radiation detection using Si(Li), HPGe, Si-Surface Barrier, MCP and Scintillator detectors; Energy and timing signal processing using Pre-Amplifier, Amplifiers, CFD and TAC; Data Acquisition using SCA, MCA , CAMAC based systems.

Suggested Readings:
1. S. N. Ghoshal, 1998, Atomic and Nuclear Physics Vol. II. S Chand & Company Ltd.
2. H. Ejiri, M. J. A. de Voigt, 1989, Gamma-ray and Electron Spectroscopy in Nuclear Physics. Oxford Studies in Nuclear Physics, Clarendon Press.
3. Glenn F. Knoll, 1979, Radiation Detection and Measurements. John Wiley & Sons.
4. K. Siegbahn, 1965, Alpha-, Beta- and Gamma-Ray Spectroscopy Vol. 2. North-Holland Publishing Company.
5. S. E. Johansson, J. L. Compbell, K. G. Malmquist, 1923, Particle Induced X-Ray Emission Spectroscopy, Vol 133. John Wiley & Sons.
6. W. R. Leo, 1987, Techniques for Nuclear and Particle Physics Experiments, Springer Verlag.

PHPR-15: Theoretical High Energy Physics   Credits: 3

Introduction to Quantum Field theory:
Introduction to Klein-Gordon and Dirac equations, solutions and antiparticles, γ-matrices, bilinear covariants, spin and helicity, two component theory of neutrinos.
Canonical quantization of scalar, electromagnetic and Dirac fields; interacting fields: $\lambda\phi^4$ theory, Wick's theorem, S-matrix.
Introduction to quantum electrodynamics (QED), Feynman diagrams and Feynman rules, application to Compton and Bhabha scattering and cross section calculations.

Introduction to Particle Physics:
Isospin symmetry, strangeness and hypercharge, SU (3) generators, Meson and Baryon multiplets, Gell-Mann Okubo mass formula; Parton model of hadrons, Bjorken scaling, quark confinement, colour and quark-gluon interactions, quantum chromodynamics (QCD), asymptotic freedom.

Weak decays and selection rules, current-current interaction and Fermi's theory; **P** and **CP** violation in weak interactions; V-A theory of weak interactions, decays of Pions and Muons and calculation of life times, weak interactions of quarks, neutral weak interactions; massive neutrinos and neutrino oscillations; Introduction to Electroweak unification.

Suggested Readings:
1. D.J. Griffiths, 1987, Introduction to Elementary Particles. John Wiley & Sons.
2. F. Halzen, A D Martin, 1984, Quarks and Leptons. John Wiley & Sons.
3. A. Lahiri, P B Pal, 2001, A first book of Quantum Field Theory. Norosa.
4. A. Das, 2008, Lectures on Quantum Field Theory. World Scientific.
5. M. E. Peskin, D. V. Schroeder, 2005, An Introduction to Quantum Field Theory. West View Press.
6. I. J. R. Aitchison, A. J. G. Hey, 1982, Gauge Theories in Particle Physics (Vol. I). Adam Hidger.
7. D. H. Perkins, 1987, Introduction to High Energy Physics. Addition Wesley.

PHPR-16:   Experimental High Energy Physics   Credits: 3

High Energy Physics Accelerators:
Classification of accelerators, principle and design of ion-sources, Linear accelerators, Large Hadron Collider (LHC), Relativistic Heavy Ion Collider (RHIC), Tevatron, storage rings.

Detectors for ionization and track measurements:
Detection of charged particles, ionization chambers, proportional counters, muti-wire proportional counters (MWPC), drift chambers, Particle measurements in liquids.

Particle Identification:
Cherenkov radiation in anisotropic and optically active media, Cherenkov radiation and bremsstrahlung, Cherenkov detectors, Classification of Cherenkov detectors (focusing and non-focusing type), transition radiation detectors; Choice of photomultiplier, Comparison of particle identification methods.

Data Analysis:
Input from detectors for data analysis, Pattern recognition and track reconstruction, Event reconstruction, Event generators, Detector simulation.

Suggested Readings:
1. T Ferbal, 1991, Experimental Techniques in High Energy Nuclear and Particle Physics. World Scientific, Singapore.
2. F. Sauli, 1992, Instrumentation in High Energy Physics. World Scientific, Singapore.
3. G.F. Knoll, 1979, Radiation Detection and Measurement. John Wiley & Sons Inc, New York.
4. D.M. Ritson, 1961, Techniques of High Energy Physics. Interscience Publishers Inc., New York.

PHPR-17: Preparation and Presentation of the Research Plan Proposal   Credits: 2

All the research scholars will be required to prepare and present his / her Research Plan Proposal and to submit it to his / her RPC.

PHPR-18:   Review, Report and Seminar on a Topic Allotted by R.P.C.   Credits: 2

Every student will be allotted a topic by his/her supervisor on which the student will collect the literature, write a REPORT and will present a Seminar before the R.P.C.

PSYCHOLOGY

(Department of Psychology)

Preamble

The students registered for Doctoral programme in the Department of Psychology will be offered various types of course work (of total 20 credits) during the two semesters of their residency period. The various course works will be offered under three categories- 1) Compulsory course work of 3 credits common for all research scholars of the Faculty of Science, 2) Discipline specific course work of 7 credits, and 3) research theme related course work of 10 credits (6 credits for course work, 2 credits for preparation and presentation research plan proposal and 2 credits for review of literature and presentation of seminar on a research theme related topic duly approved by the concerned RPC) .

Under the **discipline-specific course work,** the Ph.D. students of psychology Department will be offered two course work of which one will be core course and the other will be elective. The core course will be common to all the research scholars of the Department and the elective course will be offered (by the consultation of the RPC of the concerned student) from a pool of 5 elective courses. The name of courses and the distribution of credits have been displayed in the following table.

In the **research theme-specific courses** the research scholars of the department will be offered three courses. Two courses (of 3 credits each) will be offered from the two pools of such courses (one from each pool). The third course under this category will be of 4 credits (2 credits for preparation and presentation research plan proposal and 2 credits for review of literature and presentation of seminar).

The research scholars of the Department may be allowed to undertake research theme related courses offered by other Departments provided such facility is provided by the other Department and the RPC of the concerned student is of the opinion that it will further the knowledge and skill of the concerned student.

The specific courses offered in a given semester will be announced by the Department immediately prior to that semester. The discipline specific and research theme related courses will be evaluated and there will be only end term examination for such courses. All such examinations will be conducted by the Department. The evaluation of Research Plan Proposal and presentation, and review of literature/seminar will be done by the concerned RPC of the research student.

OUTLINE

Discipline-Specific Courses   7 credits

Course code	Title	Nature	Credits
PSPC-01	Research Methodology and Psychological Assessment.	Compulsory	4
	Any one of the following:	Elective	
PSPC-02	Clinical Psychology		3
PSPC-03	Cognitive Psychology		3
PSPC-04	Developmental Psychology		3
PSPC-05	Organizational Behaviour		3
PSPC-06	Social Psychology		3

Course code	Title	Nature	Credits
	Any one of the following:	Elective	
PSPR-01	Counselling Psychology		3
PSPR-02	Drug and Behaviour		3
PSPR-03	Human Resource Management		3
PSPR-04	Neuropsychology		3
PSPR-05	Psychology of Aging		3
	Any one of the following:	Elective	
PSPR-06	Cross-Cultural Psychology		3
PSPR-07	Human Factors		3
PSPR-08	Health Psychology		3
PSPR-09	Psychotherapy		3
PSPR-10	Personality		3
PSPR-11	Preparation and presentation of Research Plan Proposal	Compulsory	2
PSPR-12	Review of literature and presentation of a seminar on a specific research theme related topic	Compulsory	2

PSPC-01: Advanced Research Methodology and Psychological Assessment

Credits: 4

1. Analysis and interpretation of data using SPSS/Statistica; t-test, ANOVA, MANOVA, ANCOVA and post-hoc comparisons.
2. Statistical analysis and interpretation of associational research questions: Bivariate and multivariate correlation analysis using SPSS/Statistica; bivariate correlation, partial correlation, and multiple regression analysis, multiple discriminant function analysis; and exploratory and confirmatory factor analysis.
3. Psychological assessment in different settings and areas: Clinical, organizational, health, developmental and cognitive psychology and cross-cultural.

Suggested Readings:
1. A. Anastasi, S.Urbina, 1997, Psychological testing. Pearson Education, Inc.
2. A. Field, 2005, Discovering statistics using SPSS. London: Sage Publications
3. J.A. Gliner, G.A. Morgan, N.L. Leech, 2009, Research methods in applied setting: An integrated approach to design and analysis (2nd Ed.). NY: Routledge (Taylor and Francis Group).
4. Robert Ho, 2006, Handbook of univariate and multivariate data analysis and interpretation with SPSS. NY: Chapman and Hall/CRC (Taylor and Francis Group).
5. B.G. Tabachnick, L.S. Fidell, 2001, Computer-Assisted Research Design and Analysis. Prentice Hall.
6. B.G. Tabachnick, L.S. Fidell, Using Multivariate Statistics (5th Ed.). Prentice Hall.

PSPC-02: Foundations of Clinical Assessment

Credits: 3

1. Psychodiagnostics: Nature and scope. Process and stages of diagnostic assessment.

2. Sources of clinical data: The assessment interview; behavioural assessment, ratings and checklists; psychological tests. Differential diagnosis.
3. Clinical interview: Nature and types, intake, diagnostic and crisis interviewing; diagnostic interviewing skills; mental status examination; case study.

Suggested Readings:

1. H.Goldenberg, 1983, Contemporary clinical psychology (2nd Ed.) New York: Brooks & Cole.
2. C. Barker, N. Pristang, R. Elliott, 2002, Research methods in clinical psychology: An introduction to students and practitioners. NJ, USA: John Wiley & Sons.
3. J. Morrison, 2007, Diagnosis made easier. NY: Guilford Press.
4. S. Pridmore, 2000, The psychiatric interview: A guide to history taking and mental status examination. *Amsterdam*: Taylor and Francis.
5. M.T. Neitzel, D. A. Bernstein, R. Millich, 1998, Introduction to clinical psychology. (5th Ed.). Upper Saddle River, N. J.: Prentice Hall.

PSPC-03: Cognitive Psychology   Credits: 3

1. Cognition: Methods and paradigms. Approaches: Behavioural and physiological.
2. Cognitive processes: Attention and consciousness, STM and working memory.
3. Individual and situational factors in cognition: Perspectives on cognitive development, aging and gender differences in cognition. Culture and cognition.

Suggested Readings:

1. K. C. Galotti, 2008, Cognitive psychology: Perception, attention and memory. New Delhi: Cengage.
2. E. B. Goldstein, 2008, Cognitive psychology, (2nd Ed.). Belmont: Wadsworth.
3. M.W. Matlin, 2008, Cognition (7th Ed.). USA: John Wiley & Sons.
4. R. J. Sternberg, 2009, Applied cognitive psychology: Perceiving, learning, and rememberin*g*. New Delhi: Cengage.
5. H. R. Schiffman, 2000, Sensation and perception: An integrated approach. New York: John Wiley.

PSPC-04: Developmental Psychology   Credits: 3

1. Assessment in human development research: Selection of measures; observation, behavior sampling, self reports, physiological measures.
2. Designs for developmental studies: Longitudinal, cross sectional, sequential and cohorts.
3. Cultural and ethnic issues in development: Family system, school and peer group.

Suggested Readings:

1. T. P. Gullotta, G. R. Adams, 2009, Handbook of adolescent behavioral problems: Evidence-based approaches to prevention and treatment. New London: Springer.
2. R.V. Kail, J.C. Cavanaugh, 2007, Human development: A life-span view. USA :Wadsworth
3. J. W. Santrock, 2006, Life-span development. NY: McGraw Hill
4. D. R. Shaffer, K. Kipp, 2007, Developmental psychology: Childhood & adolescence. Belmont: Thomson Higher Education
5. J. W. W. Zanden, T. L. Crandell, C. H. Crandell, 2007, Human development. NY: McGraw Hill.

PSPC-05: Organizational Behaviour   Credits: 3

1. Organizational behaviour: Approaches of study, challenges in organization behavior and present status.
2. Organizational commitment: Organizational ethics; spirituality in work place; social responsibility, organizational citizenship behavior.
3. Contemporary issues in organizational behaviour: Creativity and innovation; emotional labor, psychological contract; organizational justice and control.

Suggested Readings:
1. M.G. Aamodt, 2001, Industrial and Organizational psychology. New Delhi: Wardsworth
2. F. Luthans, 2010, Organizational behaviour (12th Ed.). New York: McGraw Hill.
3. P. Murray, D. Poole, G. Jones, 2006, Contemporary issues in management and organizational behaviour. Sydney: Cengage.
4. S. P. Robbins, Judge, 2010, Organizational behaviour. New York: Prentice Hall.
5. B. M. Staw, 2002, Research in Organizational Behaviour: An annual series of analytical Essays. Oxford: Elsevier.

PSPC-06: Social Psychology   Credits: 3

1. Current perspectives on social psychology: Evolutionary and socio-cultural approaches; social neuroscience.
2. Major social problems: Population, intergroup relations and environment; dimensions and dynamics.
3. Social-psychological interventions: Nature and types; individual, group and community level interventions; problems in implementation and impact assessment.

Suggested Readings:
1. E. Aronson, T.D. Wilson, R.M. Akert, 2005, Social psychology. New Jersey: Pearson Education.
2. R.A. Baron, D. Byrne, N.R. Branscombe, 2007, Mastering social psychology. New York: Prentice Hall.
3. J.W. Berry, R.C. Mishra, R.C. Tripathi, 2003, Psychology in human and social development: Lessons from diverse cultures. New Delhi: Sage.
4. J.D. Brown, 2006. Social psychology. New York: McGraw Hill.
5. J. Pandey, 1988, Psychology in India: The-state-of-the art (vol.3). New Delhi: Sage.

PSPR-01: Counselling Psychology   Credits: 3

1. Counselling: Historical perspective. Educational developmental and preventive models; ethical issues in counselling.
2. Counselling approaches: Psychoanalytic, person-centered, existential; cognitive behavioural and electic approaches.
3. Areas of counselling: Educational, career, family and marital and gerontological; stress management oriented counselling; group counselling.

Suggested Readings:
1. C. Feltham, I. Horton, 2006, The SAGE Handbook of counselling and psychotherapy. New Delhi: Sage Pubications
2. Gelso, C.J., & Fretz, B.R. 1995, Counselling psychology. Bangalore: Prism Books Pvt. Ltd.
3. Patri, V.R. 2008, Conselling psychology. New Delhi: Authors Press.
4. Welfel, E.R. 2010, Ethics in counselling & Psychotherapy Belmont: Brooks/Cole

5. Woolfe, R., Dryden, W., & Strawbridge, S. 2003, Handbook of counselling psychology (2nd Ed.). London: Sage Publication Ltd.

PSPR-02: Drugs and Behaviour   Credits: 3

1. Methods of research in behavioural pharmacology: Tests of aggressive and defensive behaviour, operant conditioning paradigm, and seminatural learning paradigm.
2. Behavior pharmacology: Neurotransmitters, drugs and behaviour.
3. Psychopharmacology of reward: Mesolimbic dopamine pathways of reward

Suggested Readings:
1. Hart. C.L., Ksir, C., & Ray, O. (2008). Drugs, society and human behaviour. New York: McGraw Hill Higher Education.
2. Bloom, F.E., Iverson, S.D., Roth, R.H. & Iversen, L.L. (2008) Introduction to neuropsychopharmacology. New York: Oxford University Press.
3. Julien, R.M. Advokat, C.D. & Comaty, J.E. (2007) A primer of drug action: A comprehensive guide to the actions, uses and side effects of psychoactive drugs. New York: Worth Publishers.
4. Levinthal, C.F. (2009). Drugs, behaviour and modern society. Boston: Allyn & Bacon,Inc..
5. Mckim, W.A. (2006). Drugs and behaviour: An introduction to behaviour pharmacology. New Jersey: Prentice Hall

PSPR-03: Human Resource Management and Development   Credits: 3

1. Changing environment and role of human resource management: Implications of globalization for HRM and HRD; global capitalism and competitive advantages.
2. Strategic human resource management: Models and dimensions.
3. Human resource policies and practices in the Indian context.

Suggested Readings:
1. Aswathapa, K. 1996, Human resource management. Mumbai: Himalaya Publishing House.
2. Barton, J. & Jeffery, G. 1999, Human resource management: Theory and practice (2nd ed.) London: McMillan Press Ltd.
3. Decenzo, D.A. & Robbins,S.P. 2002, Human resource management (6th ed.). Singapore: John Wiley
4. Dessler, G. & Varkkey, B. 2009, Human resource management (11th ed.) New Delhi: Dovling Kindersley (India) Pvt. Ltd.

PSPR-04: Neuropsychology   Credits: 3

1. Brain functions: Principles of brain functioning- localization, globalization and lateralization.
2. Assessment of brain functions: Neuropsychological assessment, functional and structural imaging techniques, recording brain's electrical and magnetic activity.
3. Dysfunctional brain: Cognitive, affective and motor disorders of the brain; brain damage; neuroplasticity and functional recovery.

Suggested Readings:
1. D'Esposito, M. 2003, Neurological foundations of cognitive neuroscience. Cambridge: MIT.
2. Gazzaniga, M. S., & Heathreton, T. F. 2003, Psychological sciences: Mind, brain and behavior. NY: Norton & company. Inc.
3. Gazzaniga, M.S. 2002, Cognitive neuroscience: The biology of mind (2nd Ed.). New York: W.W. Norton and Company.

4. Kolb, B., & Wishaw, I. Q. 2003, Fundamentals of human neuropsychology (5th Ed.). New York: W.H.Freeman & Co.
5. Rapp, B. 2001, The handbook of cognitive neuropsychology. Chestnut Street: Psychology Press.

PSPR-05: Psychology of Aging   Credits: 3

1. Aging: Concept, characteristic features and developmental tasks; aging in India.
2. Contemporary perspectives on aging research: Creativity, leisure time activities, social networking, religiosity and spirituality. Challenges and future orientations, biological and psychological aspects of aging.
3. Specific problems of old age: Alzheimer, depression, sleep disturbance, elder abuse, and loneliness.

Suggested Readings:
1. Blackburn, J. A., & Dulmus, C. N., 2007, Handbook of gerontology: Evidence based approaches to theory, practice, and policy. USA: John Wiley
2. Hofer, S.M., & Alwin, D.F. 2008, Handbook of Cognitive Aging: Interdisciplinary perspectives. New Delhi:Sage
3. Kail, R.V. & Cavanaugh, J.C., 2009, Human Development: A Life Span view. USA: Wardsworth.
4. Rao, V.A. 1989, Psychology of old age in India. MacMillan India press.
5. Santrock, J. W. 2006, Life-span development. NY: McGraw Hill.

PSPR-06: Cross cultural Psychology   Credits: 3

1. Culture and cognition: Theoretical positions, contemporary issues; cultural influences on perception, categorization, learning, memory and problem solving; everyday cognition.
2. Culture and emotion: Recognition and judgment of emotions and emotional expressions; subjective emotional experiences.
3. Cultural change and adaptations: Enculturation and acculturation processes, acculturation strategies; behaviour shifts and acculturative stress.

Suggested Readings:
1. Berry, J. W, Poortinga, Y. H., Segall, M. H., & Dasen, P. R. 2002, Cross-cultural psychology: Research and application. New York: Cambridge University Press.
2. Berry, J. W. et al. (Eds.). 1997, Handbook of cross-cultural psychology (2nd Ed.) (Vol 1-3), Boston: Allyn & Bacon.
3. Matsumoto, D. 2001 The handbook of culture and psychology. New York: Cambridge University Press.
4. Segall, M. H., Dasen, P. R., Berry, J. W., & Poortinga, Y. H. 1999, Human behaviour in global perspective. Boston: Allyn & Bacon.
5. Shiraev, E., & Levy, D. 2009, Cross-cultural psychology. Delhi: Pearson Education.

PSPR-07: Human Factors   Credits: 3

1. Human Factors: Definition, historical overview, models of human information processing.
2. Human interaction with automation in various contexts: Automation definition, aircraft piloting, air-traffic control, automobiles and highway systems.
3. Human error: The man-machine interface; approaches to human error, errors and accidents, error proneness and accident liability.

Suggested Readings:
1. Wiener, Earl L., Kanki, B G. & Helmreich, R. L. 1993, Cockpit resource management. New York: Academic Presss.
2. Singh, I. L. & Parasuraman, R 1998, Human Cognition: A multidisciplinary perspective. New Delhi: Sage.
3. Parasuraman, R. & Mouloua, M. 1996, Automation and human performance: Theory and application. Hillsdale, NJ: Lawrence Erlbaum Associate.
4. Nickerson, R. S. 1992, Looking ahead: Human factors challenges in a changing world. Hillsdale. NJ: Lawrence Erlbaum Associate.
5. Sheridan, T. B. 2002, Humans and automation: System design and research issues. Santa Monica, CA: John Wiley.

PSPR-08: Health Psychology   Credits: 3

1. Health: Concept and models; medical and bio-psycho-social models of health; cross–cultural perspectives on health. Methods of study.
2. Major health concerns: HIV/AIDS, cancer, diabetes and CHD; health problems of

   women; intervention techniques.
3. Management of health related problems: Preventive, promotive and curative aspects of health; choice of medicinal systems; patient-doctor relationship.

Suggested Readings:
1. Aboud, F. E. 1998, Health psychology in global perspective. Thousand Oaks: Sage.
2. Baum, A. Revenson, T. A., & Singer, J. E. 2001, Handbook of health psychology. Mahwah, N. J.: Lawerence Erlbaum.
3. Brannon, L. & Feist, J. 2007, Introduction to health psychology. Thomson: Wadsworth.
4. Dimatteo, M. R., & Martin, L. R. 2002, Health psychology. Boston: Allyn & Bacon.
5. Marks, D., Murray, M., Evans, B., Willig, C., Woodall, C., & Sykes, C. M. 2005, Health psychology: Theory, research and practice. London: Sage.

PSPR-09: Psychotherapy   Credits: 3

1. Psychotherapy: Nature and goals; the client- therapist relationship; stages of psychotherapy.
2. Psychotherapeutic techniques/approaches: Modelling; assertion training. Ellis' rational emotive behaviour therapy; Beck's cognitive therapy; client-centered therapy
3. Biologically based therapies: Biofeedback; psychopharmacological therapy

Suggested Readings:
1. Brownell, J. 2002, Listening: Attitudes, principles and skills. (2nd). Boston: Allyn and Bacon.
2. Corey, G. 2009, Theory and practice of counseling and psychotherapy (8th Ed.). New York: Brooks/Cole
3. Corsini, R. J. 2001, Handbook of innovative therapy. (2nd Ed.). New York: John Wiley.
4. Hersen, M. & Sledge, W. (Eds.) 2002, Encyclopedia of psychotherapy *(Vols 1& 2)*. New York: Academic Press.
5. Kaslow, H. W. (Ed.). 2002, Comprehensive handbook of psychotherapy *(Vols. I to IV)*. New York: John Wiley and Sons.

PSPR-10: Personality   Credits-: 3

1. Trait and type approaches: Allport, Cattell, and Eysenck; Big-three and big-five models.
2. Psychodynamic and psychosocial approaches: Freud and Erikson.
3. Behaviouristic and social learning approaches: Skinner, Bandura and Mischel.
4. Humanistic and phenomenological approaches: Rogers and Kelly.

Suggested Readings:
1. Feist, J. & Fiest, G. J. (2009). Theories of personality. New York: McGraw Hill.
2. Friedman, H. S. & Schustack, M. W. (2003). Personality: Classic theory and modern research (2ndEd). Singapore: Pearson Education.
3. Funder. D. C. (2007). The personality puzzle (4thEd). New York: Norton College Books.
4. Hall, G. C., Lindzey, G., & Campbell, J. C. (1998). Theories of personality, (4thEd). New York: Wiley.
5. Larsen, R. J., & Buss, D. M. (2010). Personality Psychology: Domains of knowledge about human nature. New York: McGraw Hill.

Statistics

(Department of Statistics)

Preamble

1. Every student admitted in the Department in the Ph. D. Programme will be required to pass a Course Work of minimum of 20 credits. The 20 credit course work will normally be spread over two semesters.
2. There shall be **Three Compulsory Courses** to be taught to all the research scholars registered in the department. These courses will be taught at the faculty level.
3. There shall be Two **Discipline-Specific Courses**, of 7 credits, compulsory to all the research scholars, irrespective of their field of research. All the scholars will be required to clear these core courses.
4. There shall be Eight **Research-Theme Specific Courses** out of which a scholar will be required to opt any TWO. A scholar will also be required to prepare and present a Research Plan Proposal which will be evaluated by the concerned RPC.
5. Each theory paper, irrespective of its nature, shall be of 100 marks. The papers shall be of 3 hours duration consisting of eight full length questions in all out of which a scholar will be required to answer any five questions.

OUTLINE

Discipline-Specific Courses
Credits: 7

(Compulsory for all the research scholars)

Course Code	Title	Credits
STPC-01	Elements of Distribution Theory and Inference	3
STPC-02	Advanced Statisitcal Techniques	4
Research Theme-Specific Courses Credits: 10 Any **TWO PAPERS** out of the followings (STPR-01 to STPR-08) to be opted by a research scholar		
STPR-01	Advanced Statistical Inference and Decision Theory	4
STPR-02	Reliability and Life Testing	4
STPR-03	Applied Demography	4
STPR-04	Technical Demography	4
STPR-05	Elements of Sampling Theory	4
STPR-06	Advanced Sampling Theory	4
STPR-07	Bayesian Inference	4
STPR-08	Statistical Computing with R	4
Compulsory for all the research scholars		Credits: 2
STPR-09	Preparation and Presentation of the Research Plan Proposal	**2**

COURSE CONTENTS

STPC-01: Elements of Distribution Theory and Inference
Credits: 3

Advanced Distribution Theory:
Functions of random variables and their distributions using Jacobian of transformation and other tools. Distributions of the sum of finite number of random variables. Concept of derived distributions of a function of random variables. Sampling distributions of

sum of binomial and Poisson distributions. Convolution and compound distributions. Truncated and mixture distributions.

Review of Standard univariate discrete and continuous distributions. Their properties and applications in real world problems.

Elements of Statistical Inference:

Review of statistical inference problems. Standard point estimation. Procedures for regular and non – regular families. Theory of confidence sets with examples from bivariate and multivariate distributions. Neyman – Pearson's concept in testing of hypothesis. Generalized N – P lemma. Testing of composite hypothesis. Sequential inferential procedures. An over – view of non – parametric and semi – parametric inferential procedures.

Suggested Readings:
1. W. Feller, 1971, An Introduction to Probability Theory and Its Applications, Vol. II. Wiley.
2. B. V. Gnedenko, A. N. Kolmogorov, 1954, Limit Distributions for Sums of Independent Random Variables. Addison – Wesley Pub. Co.
3. R. G. Laha, V. K. Rohatgi, 1979, Probability Theory. Wiley.
4. A. A. Sveshnikov, 1968, Problems in Probability Theory, Mathematical Statistics and Theory of Random Functions. Dover Publications Inc, New York
5. P. L. Meyer, 1970, Introductory Probability and Statistical Applications. Amerind Pub. Co.
6. Johnson, N. L. Johnson, S. Kotz, 1970, Distributions in Statistics. John Wiley and Sons.
7. B. K. Kale, 1999, A First Course on Parametric Inference. Narosa Publishing House.
8. E. L. Lehman, 1986, Testing Statistical Hypothesis. Student Edition.
9. S. Zacks, 1971, Theory of Statistical Inference. Wiley, New York.
10. C. R. Rao, 1973, Linear Statistical Inference and its Applications. Wiley Eastern.

STPC-02: Advanced Statistical Techniques   Credits: 4

Elements of Stochastic Processes:

Poisson distribution and Poisson process. Interarrival time distribution in Poisson process. Constant hazard rate and exponential distribution. Time dependent Poisson process. Birth process. Death process. Birth - death process. Birth – death – immigration process. Random walk models. Gambler's ruin problem.

Topics on Research Methodology:

Definition and type of research. Steps in research process : Conceptual phase, empirical phase, analytical phase. Measurements. Report writing.

Topics on Multivariate Analysis:

Factor analysis : Linear factor models. Estimation of factor loadings. Factor rotation. Estimation of factor scroes. Testing goodness of fit. Cluster analysis.

Statistical Computing:

Use of computers and standard softwares like, SPSS, SAS, STATA, SYSTAT. Writing FORTRAN / C programmes for solving the problems related to the topics of CORE PAPERS – I and II.

Suggested Readings:
1. J. Medhi, 1982, Stochastic Processes. Wiley Eastern.
2. E. Parzen, 1962, Stochastic Processes. Holden – Day.
3. P. G. Hoel, S. C. Port, C. J. Stone, 1972, Introduction to Stochastic Processes. Houghton Miffin & Co.
4. E. Cinlar, 1975, Introduction to Stochastic Processes. Prentice Hall.
5. S. M. Ross, 1983, Stochastic Processes, Wiley.

6. C.R. Kothari, 1985, Research Methodology: Methods and Techniques. Wiley Eastern.
7. R.L. Dominowski, 1980, Research Methods. Prentice Hall Inc., New Jersey.
8. R.P. Mishra, 1980, Research Methodology Handbook. Concept Publishing Company, New Delhi.
9. C. R. Rao, 1973, Linear Statistical Inference and its Applications. Wiley Eastern.
10. B. Fruchter, 1967, Introduction to Factor Analysis. D. Van Nostrand Co.
11. R. Johnson, Wychern, 1992, Applied Multivariate Statistical analysis. Prentics Hall.
12. B.W. Kernighan, D.M. Ritchie, 1988, The C Programming Language, Second edition. Prentice Hall.
13. R.A. Thisted, 1988, Elements of Statistical Computing. Chapman and Hall.

STPR-01: Advanced Statistical Inference and Decision Theory   Credits: 4

Preliminary ideas of estimation. Distribution theory. Methods and properties of estimators. Sufficiency and completeness of sufficiency. Sampling distributions and characteristics of distributions. Asymptotic distributions.

Joint, marginal and conditional densities under bivariate and multivariate. Ideas to find good estimators just as preliminary and conditional specifications. Non parametric inference.

Power of test. Pearson's fundamental lemma. Likelihood ratio test. Most powerful, UMP and unbiased tests. Test procedures under different fields. Preliminary, conditional, shrunken estimators with examples.

Order statistics. Distributions of lowest, highest, rth order, range and its applications. Truncation, censoring in life testing and survival analysis. Loss function and its various forms. Risk, prior and posterior distributions. Bayes risk, Bayes and minimax rules and applications.

Suggested Readings:
1. R. Barlow, F. Proschan, 1975, Statistical Theory of Life Testing. Hold Rinehart, New York.
2. V. Barnett, T. Lewis, 1978, Outliers in Statistical Data. Wiley, Chichester, England.
3. H. Cramer, 1946, Mathematical Methods of Statistics. Princeton University Press, N.J.
4. N. L. Johnson, S. Kotz, 1969, 72, Distributions in Statistics, Vol. I, Ii, III, IV. Wiley, New York.
5. T. S. Ferguson, 1970, Mathematical Statistics: A decision Theoretic Approach. Academic Press, New York and London
6. R. V. Hogg, A. T. Craig, 1978, Introduction to Mathematical Statistics, 4th edition. MacMillan, New York
7. M. H. DeGroot, 1970, Optimal Statistical Decisions, 2nd edition. McGraw Hill, New York
8. M. G. Kendall, A. Stuart, 1979, The Advanced Theory of Statistics, vol. II, Inference and Relationship, 4th edition. MacMillan, New York
9. D. B. Owen, 1962, Handbook of Statistical Tables. Reading Mass.
10. C. R. Rao, 1973, Linear Statistical Inference and Its Applications, 2nd edition. Wiley Eastern Pvt. Ltd., John Wiley.
11. A. E. Sarhan, Bgeds Greeberg, 1962, Contribution to Order Statistics. Wiley, New York.
12. R. G. Standte, S. J. Sheather, 1990, Robust Estimation and Testing.
13. S. Zacks, 1971, The Theory of Statistical Inference. Wiley, New York.

STPR-02: Reliability and Life Testing   Credits: 4

Distribution function. Moment and characteristic functions. Reliability and hazard rates. Statistical failure models : exponential. Gamma, Weibull, Pareto, normal, lognormal and other distributions used in life testing and other fields.

Loss function (squared error, weighted, entropy, linex). Grouped and ungrouped failure data with applications.
Various types of censoring schemes and applications in life testing situations.

System, Parallel and complex system, Repair system, subjective probability, sampling vs Bayesian inference. Bayesian reliability.

Ideas of accelerated lift test, Sequential and attribute life test data.

Suggested Readings:
1. G. E. Box, G. C. Tiao, 1973, Bayesian Inference in Statistical Analysis. Addition Wesley Reading Mass.
2. R. Barlow, F. Prochan, 1975, Statistical Theory of Life Testing. Holt, Rinehart and Winston, New York.
3. J. Berger, 1980, Statistical Decision Theory. Springer, New York.
4. W. Feller, 1968, An Introduction to Probability and Its Applications, Vol. I and II. Wiley, New York.
5. N. R. Mann, R. E. Shaffer, Singapurwalla, 1973, Methods for Statistical Analysis and Reliability and Life Data. John Wiley and Sons.
6. A. M. Mood, 1950, Introduction to the Theory of Statistics. McGraw Hill, New York.
7. J. S. Maritz, 1970, Empirical Bayes Methods. Mathuen, London.
8. A. Wald, 1980, Statistical Decision Theory. Springer, New York.
9. S. K. Sinha, B. K. Kale, 1980, Life Testing and Reliability Estimation. Wiley Eastern Pvt. Ltd.

STPR-03: Applied Demography   Credits: 4

Sources of Demographic Data:
Census, CRS, SRS, NSS, Demographic surveys. Error in census and survey data: Errors of coverage and content, non-response, partial response, reporting errors (voluntary and non-voluntary response errors, heaping due to under and over reporting, recall lapse, memory bias). Non-sampling errors.

Population Composition and Changes:
Demographic and social composition, concept of aging, Pattern in population growth- India and World.

Concept and Definition of Health and Morbidity:
Sources of morbidity data, measures of morbidity.

Reproductive Health:
Concept and framework, RTI, STD's and HIV/AIDS.

Population Theories:
Theory of demographic transition, Population policies- MTP, Age of marriage, Sex determination tests, Family Welfare Program in India,NPP-2000, Status of women, Women empowerment and its demographic consequences.

Population and Development:
Impact on natural resources and environment.

Implication of population growth on food supply, water, housing, sanitation, and employment, Human Development Index.

Migration:
Differential and determinants - Migration as a response to socio-economic change. Effect of migration on places of origin and destination. Theories of migration –Theories by Raventien, Lee and Peterson. International migration. Concept and definition of urbanization.

Suggested Readings:
1. K.B. Pathak, F. Ram, 1998, Techniques of Demographic Analysis, 2nd Edition. Himalaya Publishing House, New Delhi.
2. D.J. Bogue, 1969, Principles of Demography. John Wiley & Sons Inc.
3. C.L. Chiang, 1968, Introduction of the Stochastic Processes in Biostatistics. John Wiley New York.
4. A.J. Coale, 1972, The Growth and Structure of Human Population: A Mathematical Investigation. Princeton University Press.
5. Nathan Keyfitz, 1968, Introduction to the Mathematics of Population. Addison Wesley Publishing.
6. R. Ram Kumar, 1986, Technical Demography. Wiley Eastern Limited, New Delhi.
7. M. Spiegelman, 1955, Introduction to Demography. Harvard University Press.
8. P.R. Cox, 1950, Demography. Cambridge University Press.
9. Nathan Keyfitz, H. Caswell, 2005, Applied Mathematical Demography, 3rd Edition. Springer-Verlag.
10. B.D. Mishra, 1995, An Introduction to the Study of Population. South Asian Publisher Pvt. Ltd.
11. B. Benjamin, 1968, Demographic Analysis. London: George Allen and Unwin, Ltd.
12. G.W. Barclay, 1958, Techniques of Population Analysis. John Wiley, New York.
13. S.H. Peterson, P. Heuveline, M. Guillat, 2001, Demography: Measuring and Modeling Population Processes. Blackwell Publishers. Oxford, UK:
14. NFHS I, II & III: (1992-93, 1998-99 & 2005-06), International Institute for Population Sciences, Mumbai.
15. S.N. Singh, M.K. Premi, P.S. Bhatia, A. Bose, 1988, Population Transition in India, Vol-1 & 2. B.R. Publishing Corporation, Delhi.

STPR-04: Technical Demography   Credits: 4

Concept of rates and ratios, incidence and prevalence rates. Prospective and retrospective studies, follow up studies, population exposed to the risk.

Population Estimation- Inter-censual and post-censual.

Methods of Population Projection-mathematical and components methods.

Models:
Mathematical models, deterministic vs. stochastic models, uses of models and their limitations, Davis and Blake's approach, Bongaart's model.

Fertility Models:
Biology of fertility: Menstruation, menarche and menopause, ovulation, timing of ovulation and risk of conception, gestation, fecundability. Termination of pregnancy - Spontaneous and induced abortion. Post-partum amenorrhea period. Socio-cultural factors affecting these parameters.
Models for number of births and conceptions in a given time period. Birth Intervals - first birth interval, closed birth interval, open birth interval, interior birth interval. Truncation effect on birth intervals. Sampling frame as a determinant of distribution of birth intervals. Some illustrations.
Concept of nuptiality and its measurement, SMAM.

Mortality:
Differential and determinants, IMR and its estimation, Abridged life tables, Model life tables.

Migration:
Measures of migration direct and indirect methods, migration models.

Concept of stable and semi-stable population theory, relationships of various demographic parameters under stability conditions.

Suggested Readings:
1. K.B. Pathak, F. Ram, 1998, Techniques of Demographic Analysis, 2nd Edition. Himalaya Publishing House, New Delhi.
2. D.J. Bogue, 1969, Principles of Demography. John Wiley & Sons Inc.
3. C.L. Chiang, 1968, Introduction of the Stochastic Processes in Biostatistics. John Wiley New York.
4. A.J. Coale, 1972, The Growth and Structure of Human Population: A Mathematical Investigation. Princeton University Press.
5. Nathan Keyfitz, 1968, Introduction to the Mathematics of Population. Addison Wesley Publishing.
6. R. Ram Kumar, 1986, Technical Demography. Wiley Eastern Limited, New Delhi.
7. M. Spiegelman, 1955, Introduction to Demography. Harvard University Press.
8. P.R. Cox, 1950, Demography. Cambridge University Press.
9. Nathan Keyfitz, H Caswell, 2005, Applied Mathematical Demography, 3rd Edition. Springer-Verlag.
10. B.D. Mishra, 1995, An Introduction to the Study of Population. South Asian Publisher Pvt. Ltd.
11. B. Benjamin, 1968, Demographic Analysis. London: George Allen and Unwin, Ltd.
12. G.W. Barclay, 1958, Techniques of Population Analysis. John Wiley, New York.
13. S.H. Peterson, P. Heuveline, M. Guillat, 2001, Demography: Measuring and Modeling Population Processes", Oxford, UK: Blackwell Publishers.
14. NFHS I, II & III: (1992-93, 1998-99 & 2005-06), International Institute for Population Sciences, Mumbai.
15. S.N. Singh, M.K. Premi, P.S. Bhatia, A. Bose, 1988, Population Transition in India, Vol-1 & 2. B.R. Publishing Corporation, Delhi.

STPR-05: Elements of Sampling Theory   Credits: 4

Basic Concepts in Sampling:
Population, sample, sampling design, sampling frame, target and frame populations. Need and importance of probability sampling. Planning of large scale sample surveys : operations and associated errors. Acquaintance with the working (questionnaire, sampling design, methods followed in field investigation, principal findings, etc.) of NSSO and other agencies undertaking sample surveys. Concept of design effect.

Issues in Stratified Random Sampling:
Allocation problems involving several auxiliary variables; re-weighting by strata sizes; two – way stratification and its comparison with one – way stratification; stratum boundary determination problems.

Probability Proportional to Size Sampling:
πps and pps sampling; Horvitz – Thompson's estimator (THE); variance of THE, its estimation and related issues; IPPS schemes of sampling due to Midzuno – Sen, Brewer, Durbin and JNK Rao (sample size 2 only), Rao-Hartley-Cochran sampling scheme for sample size n with random grouping.

Two – stage sampling with unequal number of second stage units; stratified multi – stage sampling

Multi – phase sampling for ratio, regression, pps estimation and for stratification.

Certain important classes of estimators with and without auxiliary information. Jackknife technique; bootstrap technique.

Repetitive Surveys:
Minimum variance current estimates; estimation of change; optimum replacement policy; regression estimation in repetitive surveys.

Suggested Readings:
1. W. G. Cochran, 1977, Sampling Techniques, 3rd ed.. Wiley Eastern.
2. M. N. Murthy, 1977, Sampling Theory and Methods, 2nd ed. Stat. Pub. Soc.
3. L. Kish, 1965, Survey Sampling. Wiley
4. P. Mukhopadhyay, 2000, Theory and Methods of Survey Sampling. Prentice Hall of India.
5. C. E. Sarndal, B. Swensson, J. Wretman, 1992, Model Assisted Survey Sampling. Springer – Verlag.
6. P. V. Sukhatme, B. V. Sukhatme, S. Sukhatme, C. Asok, 1984, Sampling Theory of Surveys with Applications. Iowa State University Press, Iowa.
7. Des Raj, P. Chandhok, 1999, Sample Survey Theory. Narosa Publishing House.
8. A. Chaudhari, J. W. E. Vos, 1988, Unified Theory and Strategies of Sampling. North Holland, Amsterdam.
9. S. Singh, 2003, Advanced Sampling Theory with Applications: How Michael "Selected" Amy. Kluwer Academic Publishers, The Netherlands.

STPR-06: Advanced Sampling Theory   Credits: 4

Non–Sampling Errors:
Different kinds of non – sampling errors. Frame imperfections. Estimation in the presence of frame imperfections.

Non–Response:
Sources of non – response; unit and item non – response and their measures; Dealing with non – response : call backs and follow – ups; sub-sampling of non – respondents; imputation techniques for unit and item non – response.

Measurement Errors:
Nature of measurement errors; models of measurement errors for estimating population parameters. Interpenetrating sub-samples.

Randomized Response Technique:
Warner's model; related and unrelated questionnaire models; use of binary responses.

Issues in Small Area Estimation:
Preliminaries; background of domain estimation; basic estimation methods for domains; direct estimators; synthetic estimators; generalized regression estimators.

Model based inference from survey samples : super-population model approach; principles of inference based on theory of prediction; prediction under polynomial regression models; prediction under multiple regression models; balanced samples.

Suggested Readings:
1. P. Mukhopadhyay, 2000, Theory and Methods of Survey Sampling. Prentice Hall of India.
2. C. E. Sarndal, B. Swensson, J. Wretman, 1992, Model Assisted Survey Sampling. Springer – Verlag.

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3. Des Raj and P. Chandhok, 1999, Sample Survey Theory. Narosa Publishing House.
4. A. Chaudhari, R. Mukerjee, 1988, Randomized Response: Theory and Techniques. Marcel Dekker Inc., New York.
5. A. S. Hedayat, B. K. Sinha, 1991, Design and Inference in Finite Population Sampling. Wiley.
6. P. Mukhopadhyay, 1996, Inferential Problems in Survey Sampling. New Age International Pvt. Ltd.
7. P. Mukhopadhyay, 1998, Small Area Estimation in Survey Sampling. Narosa.
8. S. Singh, 2003, Advanced Sampling Theory with Applications: How Michael "Selected" Amy. Kluwer Academic Publishers, The Netherlands.

STPR-07: Bayesian Inference   Credits: 4

Bayesian vs. classical way of reasoning, subjective notion of probability, prior distribution and its elicitation, posterior distribution and predictive distribution.

An overview of Bayesian inference with due emphasis on point estimation, credible estimation and testing.

Normal theory inference problems concerning location and scale parameters, Inference about location and scale parameters for a wider class of models with normal as a particular member, sensitivity of inferences for departures from normality.

Hierarchical and empirical Bayes procedures, Sequential Bayes procedures.

Bayes computation : Numerical integration, analytic approximation and simulation based techniques. Ideas on Bayesian robustness.

Suggested reading:
1. J. O. Berger: Statistical Decision Theory and Bayesian Analysis. Springer Verlag.
2. C. P. Robert, G. Casella: Monte Carlo Statistical Methods. Springer Verlag.
3. G. P. Box, G. C. Tiao: Bayesian Inference in Statistical Analysis. Addison – Wesley.
4. J. M. Bernando, A. F. M. Smith: Bayesian Theory. John Wiley & Sons.

STPR-08: Statistical Computing with R   Credits: 4

R Programming:
Introduction and some preliminaries concepts, simple manipulation with numbers and vectors, object their modes and attributes, arrays and matrices, reading data from files, conditional execution and looping, writing own functions, graphical procedures.
Codes for generating standard distributions using R, examining distribution of a set of data, one and two sample tests, Statistical models in R : linear, generalized linear and non – linear models.
Practical assignments based on the above topics.

STPR-09: Preparation and Presentation of the Research Plan Proposal   Credits: 2

ZOOLOGY

(Department of Zoology)

Preamble

The research scholars of Department of Zoology shall have to undergo a Ph.D. course work of 20 credits, to be completed in 2 semesters. The course comprises three components, the Faculty Level Common Courses (3 credits), Discipline-Specific Courses (7 credits) and Research Theme-Specific Courses (10 credits). The Discipline-Specific Courses comprise two theory and one laboratory – based courses. The Course I (theory) has been prepared to offer choices to the research scholars. The Research theme - specific courses comprise of 10 Elective courses of 3 credits each and 2 Compulsory courses of 2 credits each. A research scholar shall choose two Elective courses as suggested by the concerned RPC and the Compulsory courses to earn 10 credits. The details of discipline-specific and research theme-specific courses are given below:

OUTLINE

Course Code	Course title	Credits
Discipline-Specific Courses		Credits: 7
ZOPC-01	Techniques in Biological Research*	2
	Module 1: Cell Biological and Histochemical Techniques	
	Module 2: Biochemical Techniques	
	Module 3: Molecular Biological techniques	
ZOPC-02	Bioinformatics & Biostatistics	2
ZOPC-03	Laboratory exercises based on ZOPC-01 & ZOPC-02	3
** **Research Theme-Specific Courses**		Credits: 10
ZOPR-01	Agricultural Entomology	3
ZOPR-02	Cytogenetics & Genetics	3
ZOPR-03	Endocrinology (based on mammals)	3
ZOPR-04	Fertility and Sterility	3
ZOPR-05	Fish Physiology	3
ZOPR-06	Fish Reproduction, Breeding and Biotechnology (based on Teleosts)	3
ZOPR-07	Functional Genomics	3
ZOPR-08	Insect Physiology	3
ZOPR-09	Recent Trends in Biochemistry-I	3
ZOPR-10	Recent Trends in Biochemistry-II	3
ZOPR-11	Preparation of Research Plan Proposal (write up), Presentation and defense	2
ZOPR-12	Review of literature and presentation of a seminar on a research-theme related topic duly approved by the concerned RPC.	2

*Any two modules (theory and corresponding laboratory exercises) to be selected by a student
** Student can opt any **two** elective papers from ZOPR-01 to ZOPR-10.
ZOPR-11 and ZOPR-12 are compulsory courses.

ZOPC-01: Techniques in Biological Research   Credits: 2

Each Ph D scholar shall choose any two of the three modules (theory and corresponding laboratory exercises).

MODULE I: Cell Biological and Histochemical Techniques   Credit: 1

1. Microscopy : Basic principle and types

2. Cell culture techniques : Primary and secondary culture, Cell lines and their maintenance, Cryopreservation
3. Detection of gene expression at cellular level

3.1 Hybridization based: In situ hybridization
3.2 Antibody based: Immunocytochemical detections
3.3 Reporter assay based: Use of *lacZ*, GFP, luciferase-luciferin reporters
4.   Chromosomal analysis: Karyotype, banding and nomenclature

5. Cell viability and apoptosis

6. Histological and histochemical techniques

6.1 Tissue fixation and staining
6.2 Histochemical techniques to detect carbohydrates, proteins and lipids
6.3   Enzymes as histochemical reagents

Suggested Readings:
1. Alberts et al., 2008, Molecular Biology of the Cell. Garland
2. Bancroft & Stevens, 2002, Theory and Practice of Histological Techniques, Churchill-Livingstone
3. Karp, 2008, Cell & Molecular Biology, Wiley
4. ISCB, 2010, Cell Biology Protocols.
5. Lodish et al., 2008, Molecular Cell Biology, Freeman
6. Pears, 1993, Histochemistry: Theoretical & Applied (Vol I, II, III), Churchill-Livingstone

MODULE II: Biochemical Techniques   Credit: 1

1. Homogenization and centrifugation

2. Spectrophotometry: Principle and applications of UV-vis spectrophotometry

3. Chromatography

    3.1 Principle of gel filtration, ion-exchange and affinity chromatography
    3.2 Introduction to HPLC, FPLC
4. Electrophoresis: Principle and applications of

    4.1 PAGE (native, denaturing and 2D)
    4.2 Agarose gel electrophoresis
5. Radioisotopes and hazardous chemicals: Uses and safety measures
6. Principle and applications of bioassay, RIA, ELISA

7. Enzyme assay

Suggested Readings:
1. Boyer, 2005, Modern Experimental Biochemistry and Molecular Biology, Benjamin
2. Wilson & Walker, 2006, Principles of Biochemical and Molecular Biological Techniques, Cambridge Univ. Press.

MODULE III: Molecular Biological Techniques   Credit: 1

Theory

1. Introduction to recombinant DNA technology
    1.1 Restriction endonucleases
    1.2 Cloning vectors
    1.3 Transformation
2. Identification of gene and gene products
    2.1 Preparation of probe; Southern, Northern and slot hybridizations
    2.2 Western blotting, immunoprecipitation, yeast two hybrid system
3. Basic principle and applications of :
    3.1 Designing of primers and polymerase chain reaction
    3.2 DNA sequencing
    3.3 Microarray
    3.4 Site directed mutagenesis
    3.5 Mass spectrometry
4. Promoter characterization: Electrophoretic mobility shift assay, DNA footprinting1
5. Transgenesis

Suggested Readings:
1. Brown, 1995, Gene Cloning, Stanley
2. Brown, 2007, Genomes 3, Garland
3. Drlica, 2003, Understanding DNA and Gene Cloning, Wiley
4. Glick & Pasternak, 1994, Molecular Biotechnology, ASM press
5. Micklos & Freyer, 1990, DNA Science, CSHL
6. Sambrook et al, 2001, Molecular Cloning: A Laboratory Manual (Vol I, II, III), CSHL
7. Watson et al, 1992, Recombinant DNA, Pearson

ZOPC-02: Bioinformatics & Biostatistics   Credits: 2

Section A: Bioinformatics   Credit: 1

1. Introduction to computers, networks and information technology
2. Introduction and scope of Bioinformatics: A concept of digital laboratory
3. Introduction to data archiving systems: FASTA format, Accession, and GI-Number

4. Databases, search and retrieval: NCBI, Swiss-prot, PIR, PDB, KEGG, PubMed
5. Concept of homology: BLAST, Clustal-X and their applications
6. Protein structure bioinformatics:
    Protein visualization, structure comparison, homology modeling

Suggested Readings:
1. Barnes & Gray, 2003, Bioinformatics for Geneticists. Wiley
2. Campbel, 2006, Discovering Genomics, Proteomics and Bioinformatics. LPE
3. Hunt & Livesey, 2006, Functional Genomics. Oxford
4. Lesk, 2006, Bioinformatics 2/e. Oxford
5. Mount, 2006, Bioinformatics 2/e. CBS
6. Westhead et al, 2003, Bioinformatics Instant Notes. Viva Books (Indian ed)

Section B: Biostatistics   Credit: 1

1. Collection and classification of data, Graphical presentation of qualitative and quantitative data (Bar diagram, Pie diagram, Histogram, Frequency polygon, frequency curve and ogive, and box plot)
2. Measures of central tendency (mean, median and mode), measures of dispersion (variance and standard deviation), concept of coefficient of variation, skewness and kurtosis
3. Correlation (continuous data and ordinal data) and regression (linear and curvilinear), concept of coefficient of determination
4. Concept of probability
5. Concept of standard error and p value, parametric test (Z and t, both paired non-parametric and unpaired) and test (Chi-square)
6. Analysis of variance: one way and multiple comparison, post-hoc tests

Suggested Readings:
   1. Bruning &.Kintz, 1977, Computational Handbook of Statistics, Scott
   2. Daniel, 2000, Biostatistics: A Foundation for Analysis in Health Sciences, John Wiley.
   3. Milton & Tsokos, 1983, Statistical Methods in the Biological and Health Sciences, McGraw Hill
   4. Quinn & Keough, 2002, Experimental Design and Data Analysis for Biologists, Cambridge Univ
   5. Rastogi, 2008, Fundamentals of Biostatistics, ANE Books
   6. Sharma, 2008, Text Book of Biostatistics-I&II, Discovery Publishing
   7. Snedecor & Cochran,1968, Statistical Methods, Oxford & IBH
   8. Sokal & Rohlf, 2000, Biometry, Freeman.
   9. Steel & Torrie, 1980, Principles and Procedure of Statistics: A Biometrical Approach, McGraw Hill Book Co.
   10. Zar, 2003, Biostatistical Analysis, Pearson

ZOPC-03: Laboratory Exercises based on ZOPC-01 & ZOPC-02   Credits: 3

Section A: Laboratory exercises based on ZOPC-01   Credit: 1

Module I: Cell Biological and Histochemical Techniques   Credit: 1

1. Familiarization with research microscope and stereobinocular microscope
2. Observation under phase contrast, fluorescence, confocal and electron microscopes
3. Familiarization with *Drosophila*, setting-up of a cross, polytene chromosome preparation
4. Handling of rats/mice, surgical ablation of endocrine glands
5. Sterilization, preparation of media and cell culture
6. *lacZ* reporter assay for studying gene expression
7. Chromosome preparation from bone marrow of rat/mouse and G-banding, human karyotyping
8. Trypan blue dye exclusion test for cell viability
9. Tissue fixation, paraffin block preparation, sectioning and staining
10. Histochemical staining for proteins and lipids
11. Immunohistochemical detection of proteins

Module II: Biochemical Techniques   Credit: 1

1. Preparation of solutions and buffers
2. Preparation of homogenate and sub cellular fractionation by differential centrifugation
3. Verification of Beer's law; quantitation of biomolecules by spectrophotometric analysis
4. Separation of biomolecules by gel filtration chromatography

5. SDS-PAGE and agarose gel electrophoresis
6. Enzyme assay
7. Demonstration of ELISA
8. Raising antibodies

Module III: Molecular Biological Techniques   Credit: 1

1. Isolation of genomic DNA and plasmid DNA
2. Digestion of DNA by restriction endonuclease and cloning of a fragment of DNA
3. Amplification of a fragment of DNA by polymerase chain reaction
4. Southern hybridization (demonstration)
5. Isolation of RNA and RT-PCR
6. Analysis of proteins by western blotting

Section B: Laboratory exercises based on ZOPC-02   Credit: 1

Bioinformatics
1. Familiarization with computer operations, TCP/IP, file formats
2. Data archiving and retrieval systems: Accession and GI number, WebIn/BankIT
3. Demonstration of web-pages related to biological information (NCBI, ExPasy)
4. Hands-on practice of the features of following databases: PubMed, GeneBank, PDB, OMIM, Fly Base, HGDB, MGDB, KEGG, RNAdb
5. Hands on practice of the features of following software packages/tools: BLAST, Clustal-W, PHYLIP
6. Structure, visualization and analysis of protein

Biostatistics
1. To depict a hypothetical continuous frequency distribution table in the form of histogram, frequency polygon and ogive
2. Calculations of mean, median and mode from hypothetical data
3. To calculate variance, standard deviation, standard error and coefficient of variation from hypothetical data
4. Testing hypothesis by applying chi-square test
5. Applications of ANOVA for testing variation in different sets of experimental data

RESEARCH THEME-SPECIFIC COURSES

ZOPR-01: Agricultural Entomology   Credits: 3

1. Insect – plant interactions
   1.1 Herbivory
      1.1.1 Leaf chewing
      1.1.2 Plant mining and boring
      1.1.3 Sap sucking
      1.1.4 Gall formation
      1.1.5 Seed predation
   1.2 Insect feeding preference and host-plant selection
   1.3 Plant toxins and their effect on insects
   1.4 Insects and plant reproductive biology
      1.4.1 Pollination
      1.4.2 Myrmecochory
   1.5 Host-plant resistance
2. Ground-dwelling insects
      2.1 Insect-fungal interactions
      2.1.1 Fungus farming by leaf-cutter ants
      2.1.2. Fungus cultivation by termites

3. Environmental monitoring using aquatic insects

4. Insect pests of crops
    4.1 Major pests of the following crops, their life cycles, nature of damage caused and pest management: paddy, pulses, cotton crops, vegetables, fruits and stored grain
    4.2 Polyphagous insect pest: locusts, termites, gram pod borer, aphids
5. Environmental impact of insecticides
    5.1 Insect resistance to insecticides and resurgence
    5.2 Effect on non-target animals

Suggested Readings:
    1. Alford, 1999, A textbook of Agricultural Entomology, Blackwell.
    2. Atwal, 1986, Agricultural pests of India and South-East Asia, Kalyani Publishers.
    3. Dhaliwal and Arora, 1996, Principals of Insect Pest Management, National Agricultural Technology Information Centre, Ludhiana
    4. Dhaliwal and Arora, 1994, Trends in Agricultural Insect Pest Management, Commonwealth Publ.
    5. Gillot, 1995, Entomology, 2nd Edition, Plenum Press
    6. Gullan & Cranston, 2000, The Insects: An Outline of Entomology, 2nd Edition, Blackwell
    7. Harborne, 1993, Introduction to Ecological Biochemistry, 4th Edition.
    8. Hill, 2002, Pest of Stored Foodstuffs and Their Control, Springer
    9. Imms, 1997, A General Text Book of Entomology,2 Volumes, Asia Publishing House
    10. Norris et al, 2002, Concepts in Integrated Pest Management, Prentice-Hall
    11. Pedigo, 2002, Entomology and Pest Management, 4th Edition, Prentice Hall
    12. Pruthi, 1969, A Text Book of Agricultural Entomology, ICAR, New Delhi
    13. Racheigl and Racheigl, 1998, Biological and Biotechnological Control of Insect Pests, CRC Press
    14. Schoonhoven et al., 1998, Insect-Plant Biology- from Physiology to Evolution, 1st Edition, Chapman & Hall
    15. Srivastava, 2001, A Text Book of Applied Entomology, Vol. I & II, 2nd Edition, Kalyani Publ.

ZOPR-02: Cytogenetics & Genetics   Credits: 3

1. Eukaryotic chromatin structure and chromosome organization
    1.1 Classes of DNA
    1.2 Chromosomal proteins: histones and their modifications, non-histone proteins, scaffold/matrix proteins
    1.3 Levels of chromatin condensation at interphase and metaphase stages
    1.4 Nuclear matrix and organization of interphase nucleus
    1.5 Centromere, kinetochore and telomere
    1.6 Metaphase chromosome banding
2. Human cytogenetics and genetics
    2.1 Karyotype and nomenclature of metaphase chromosome bands
    2.2 Types of chromosome anomalies
    2.3 Chromosome anomalies and disease
    2.4 Fragile site and X-linked mental retardation
    2.5 Pedigree construction, inheritance patterns and risk assessment
    2.6 Consanguinity and its effects
    2.7 Multifactorial traits
3. Mendel's laws and their chromosomal basis
4. Methods of gene mapping
    4.1 Three-point test cross in *Drosophila*
    4.2 Gene mapping in bacteria by conjugation, transformation and transduction
5. Gene mutation and DNA repair

     5.1 Types of gene mutations
     5.2 Methods for detection of induced mutations
     5.3 P-element insertional mutagenesis in *Drosophila*
     5.4 DNA damage and repair
6. Nature of the gene and its functions
     6.1 Evolution of the concept of gene
     6.2 Fine structure of gene (*rII* locus)
     6.3 Regulation of gene activity in *lac* and *trp* operons of *E.coli*
     6.4 Introduction to gene regulation in eukaryotes
7. Developmental genetics
     7.1 Model organisms for genetic studies
     7.2 Genetic control of embryonic development and pattern formation
     7.3 Stem cells and tissue engineering
8. Cancer genetics
     8.1 Cell cycle dysregulation
     8.2 Instability of the genome
9. Population and evolutionary genetics
     9.1 Genetic constitution of a Mendelian population
     9.2 Elemental forces of evolution
     9.3 Genetic polymorphisms

Suggested Readings:
1. Alberts et al, 2008, Molecular Biology of the Cell, Garland.
2. Becker et al, 2009, The world of Cell, Pearson.
3. Brooker, 1999, Genetics : Analysis and Principles, Addison-Wesley.
4. Futuyma, 2005, Evolution, Sinauer.
5. Gardner et al, 2006, Principles of Genetics, John Wiley.
6. Gilbert, 2006, Developmental Biology, Sinauer.
7. Griffith et al, 2005, Modern Genetic Analysis, Freeman.
8. Hall & Hallgrimsson, 2008, Strickberger's Evolution, Jones & Bartlett.
9. Hartl & Jones, 2009, Essential Genetics: A Genomic Perspective, Jones & Bartlet
10. Hartl & Clark, 2007, Principles of Population Genetics, Sinauer.
11. Hedrick, 2005, Genetics of Populations, Jones & Bartlet.
12. Karp, 2007, Cell and Molecular Biology, John Wiley & Sons.
13. Klug et al, 2009, Concepts of Genetics, Pearson.
14. Lewin, 2011, Genes X , Jones & Bartlett.
15. Lewis, 2007, Human Genetics, WCB McGraw.
16. Lodish et al, 2008, Molecular Cell Biology, Freeman.
17. Mange and Mange, 1999, Basic Human Genetics, Sinauer.
18. Pollard & Earnshaw, 2002, Cell Biology, Saunders.
19. Rooney, 1987, Human Cytogenetics, Oxford.
20. Russell, 2002, Genetics, Benjamin Cummings.
21. Snustad & Simmons, 2010, Principles of Genetics, John Wiley.
22. Strachan & Read, 2011, Human Molecular Genetics, Wiley.
23. Wolpert, 2002, Principles of Development, Oxford.

ZOPR-03: Endocrinology   Credits: 3

(Based on Mammals)

1. Mechanism of hormone action
     1.1 Protein hormones
          1.1.1 Membrane receptors
          1.1.2 G-proteins
          1.1.3 Cyclic AMP signaling cascade
          1.1.4 PKC signaling pathway
          1.1.5 Tyronine kinase pathway
          1.1.6 Nitric oxide signaling pathway

1.2 Steroid hormones (genomic and nongenomic pathways)
2. Hypothalamo-hypophysial System
   2.1 General organization
   2.2 Neurohypophysial octapeptides (oxytocin and vasopressin)
   2.3 Adenohypophysial hormones: chemistry and physiological roles of:
       2.3.1 Somatotropin and prolactin
       2.3.2 Glycoprotein hormones (FSH, LH and TSH)
       2.3.3 Pro-opiomelanocortin (ACTH, MSH, -LPH and -endorphin)
   2.4 Neural control of adenohypophysis
3. Thyroid hormones: biosynthesis, control of secretion and physiological roles
4. Steroid hormones: biosynthetic pathways
5. Testis: organization and physiological roles of androgens
6. Ovary: organization and physiological roles of estrogen, progesterone,
   relaxin and inhibin
7. Adrenal
   7.1 Organization
   7.2 Control of mineralocorticoid and glucocorticoid hormones
   7.3 Physiological role of glucocorticoids and mineralocorticoids
   7.4 Catecholamine biosynthesis, release and physiological role

8. Role of parathormone, calcitonin and vitamin D in calcium homeostasis
9. Endocrine pancreas: biosynthesis and physiological actions of insulin
   and glucagon
10. Pineal gland
    10.1 Pineal, biological clock and calendar
    10.2 Melatonin and photoperiodic measurement

Suggested Readings:
1. Bentley, 1998, Comparative Vertebrate Endocrinology, Cambridge University Press.
2. Chester-Jones et al, 1987, Fundamentals of Comparative Endocrinology, Plenum Press.
3. Gorbman et al,1983, Comparative Endocrinology, John Wiley.
4. Norris, 2007, Vertebrate Endocrinology. 4th Edition, Elsevier.
5. Schreibman & Pang, 1985, Vertebrate Endocrinology, Vol I-IV, Fundamentals & Biomedical Implications, Academic Press.
6. Hadley, 2000, Endocrinology, International Edition, Prentice Hall.
7. Brooks and Marshall,1995, Essentials of Endocrinology, Blackwell Science.
8. Turner and Bagnara, 1984, General Endocrinology, Saunders.
9. Larson, 2002, Williams Textbook of Endocrinology,10th Edition, Saunders.

ZOPR-04: Fertility and Sterility   Credits: 3

1. Overview of regulation of menstrual cycle
2. Control of male fertility
   2.1 Chemical interference
       2.1.1 Suppression of spermatogenesis
           2.1.1.1 Suppression of hypophysial activity by steroid hormones
           2.1.1.2 Chemicals acting directly on the testis
       2.1.2 Prevention of sperm maturation in epididymis
   2.2 Immunological interference
   2.3 Surgical interference with reference to vasectomy
3. Control of female fertility
   3.1 Inhibition of ovulation with reference to oral contraceptives
   3.2 Mechanical methods with reference to intrauterine devices
4. Male sterility
   4.1 Parameters of male sterility
   4.2 Origin and cause of male sterility
       4.2.1 Azoospermia
       4.2.2 Oligozoospermia

       4.2.3 Varicocoele
       4.2.4 Cryptorchidism
     4.3 Lifestyle factors and male sterility
5. Female sterility
     5.1 Tubal factors
     5.2 Premature ovarian failure
     5.3 Polycystic ovarian syndrome
     5.4 Luteal insufficiency
     5.5 Endometriosis
6. Assisted reproductive techniques (ART)
     6.1 Principles of ART and protocols
     6.2 Types of ART
     6.3 Cryopreservation of gametes
7. Primer pheromones
     7.1 Estrous cycle disruption
     7.2 Male induction of estrus (Whitten effect)
     7.3 Male induced pregnancy block (Bruce effect)
     7.4 Pheromones and puberty
     7.5 Human reproductive pheromones

Suggested Readings:
1. Leung and Adashi, 2004, The Ovary, Raven Press
2. Adashi et al, 1996, Reproductive Endocrinology, Surgery and Technology, Lippincott-Raven Publishers
3. Findlay, 1994, Molecular Biology of the Female Reproductive System, Academic Press
4. Knobil & Neill, 1994, The Physiology of Reproduction, Vol. I & II, Raven Press
5. Knobil & Neill, 1998, Encyclopedia of Reproduction, Vol. 1-4, Academic Press
6. Lamming Marshall's, 1984, Physiology of Reproduction, Longman
7. Mann & Lutwak-Mann, 1998, The Male Reproductive Function and Semen, Springer
8. Paulson et al, 1986, Andrology: Male Fertility and Sterility, Academic Press
9. Setchell, 1992, The Mammalian Testis, Cornell University Press
10. Yen et al, 1999, Reproductive Endocrinology, Saunders

ZOPR-05: Fish Physiology   Credits: 3

(**Based on Teleosts**)

1. Integument
1.1.   Epidermis
1.1.1. Mucogenic
1.1.2. Keratinized
1.2.   Dermis
1.2.1. General organization
1.2.2. Scales
1.2.3. Chromatophores
2.   Respiration
2.1   Aquatic respiration
2.1.1. Gills
2.1.2. Mechanisms of respiration
2.1. 2.1. Counter current principle
2.1.2.2. Water flow across the gills
2.1.2.3. Respiratory pump
2.1.2.4. Pump musculature and skeleton
2.1.2.5. Gas exchange
2.2. Air-breathing
2.2.1 Accessory respiratory organs and respiratory epithelium

2.2.2 Physiological adaptation in air-breathing fishes

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2.3. Transport of respiratory gases

3. Digestion
3.1 Alimentary canal and its modifications in relation to food and feeding habits

3.2 Digestive fluids and enzymes.

3.3 Digestion and absorption of lipids, proteins and carbohydrates

3.4 Gastrointestinal motility control
4. Swim bladder
4.1 General organization and circulation

4.2 Composition of swim bladder gas, its secretion and maintenance

4.3 Removal of gas from swim bladder
4.4 Functions of swim bladder
5. Circulation
5.1. Heart and aortic arches
5.2. Regulation of cardiac activity
5.3. Hemodynamics
5.4. Cardiac output
5.5. Circulation time
5.6. Blood pressure
5.7. Fish hemoglobin

Suggested Readings:
1. Bond, C.E., 1979, Biology of Fishes, Saunders College Publishing Philadelphia.
2. Brown, M.E., The Physiology of Fishes Vol. I & II. Academic Press, 1953 & 1957
3. C.I.F.R.I., Prawn Fisheries Bulletin No. 10, 1977.
4. Datta-Munshi, J.S. & Hughes G. M., 1992, Air-Breathing Fishes of India, Oxford and IBH Publ. Co. New Delhi.
5. Evans, D.H., 2006, The Physiology of Fishes, CRC Press.
6. Hoar W.S. & Randall, D. J., Fish Physiology, Series Vol. I - XIV, Academic Press, Howard & Churchill, Canning technology. London.
7. Hughes, G. M., 1967, Comparative Physiology of Vertebrate Respiration, Heinemann Educational Books Ltd.
8. Khanna S. S. and H. R. Singh, 2003, A textbook of Fish Biology and Fisheries, Narendra Publishing House.
9. Lagler, K. F., Bardach J.E., Miller R.R. and May Passino, D.R., 2003, Ichthyology, John Wiley.
10. Nilsson, S. & Holmgren, S., 1986, Fish Physiology Recent Advances, Croom Helm, London.
11. Singh, B. R. Advances in Fish Research, Vol. I, II and III (Ed. Munshi, J.S.D.) Narendra Publishing House, Delhi 1993 and 1997.
12. Gupta S.K. and Gupta, P.C., General and Applied Ichthyology (Fish and Fisheries), S. Chand & Co., New Delhi

ZOPR-06: Fish Reproduction, Breeding And Biotechnology   Credits: 3

(Based on Teleosts)

1. Functional morphology of gonads
    1.1 General organiztion of gonad
    1.2. Oogenesis and spermatogenesis
    1.3. Vitellogenesis and its hormonal regulation
    1.4 Final Oocyte maturation
    1.5 Role of environmental factors on gonad maturation

      1.6   Gonadal steroidogenesis and its control
2. Role of hypothalamo-hypophyseal hormones in reproduction
3. Reproductive behaviour and pheromones
4. Types and mode of reproduction
5. Secondary sexual characters
6. Bisexuality and hermaphroditism
7. Parental care.
8. Induced breeding
    8.1 Factors reponsible for induced breeding
    8.2 Hypophysation
    8.3 Use of different synthetic and natural hormones, their formulation and mechanism of
        action
    8.4 Bundh Breeding
    8.5 Happa Breeding
    8.6 Hatchery Breeding
1. Multiple breeding of carps
2. *In vitro* fertilization and incubation
3. Fish seed collection, transport of brood fish and fish seed
12. Fundamentals of fish genetics
13. Fish Biotechnology
    1. 1. Gynogenesis
    1.   Androgenesis
    2.   Polyploidy & and sterile fish
    3.   Production of monosex population.
    4.   Hybridization
    5.   Cryo-preservation of gametes and embryo
    6.   Transgenic fish
    7.   sex reversal

Suggested Readings:
1. Bentley, P. J., 2000, Comparative Vertebrate Endocrinology, Cambridge University Press.
2. Brown, M.E., 1953 & 1957, The Physiology of Fishes Vol. I, II., Academic Press
3. Evans,D.H., 2006, The Physiology of Fishes, CRC Press.
4. Hoar W.S. & Randall, D. J., Fish Physiology, Series Vol. I - XIV, Academic Press
5. Proceedings of International Symposium on Reproductive Physiology of fishes. 1991, 1995, 1999, 2003, 2007
6. Gupta S.K. and Gupta, P.C. General and Applied Ichthyology (Fish and Fisheries), S. Chand & Co., New Delhi
7. Lakra, Abidi Mukherjee and Ayyappan, 2004, Fishery Biotechnology, Narendra Pub. House, Delhi

ZOPR-07: Functional Genomics   Credits: 3

1. Diversity of genomes
    1.1 Overview of pro- and eukaryotic genomes
    1.2 Integrated map and organization of human genome
    1.3 Modes of genomic innovations: Mutations, gene duplication: gene families, pseudogenes, Transposable elements
    1.4 Horizontal transfer of genomes
2. Genomic expression analysis
    2.1 Concepts and methods of transcriptome and proteome analysis
    2.2 Applications in human disease
3. Pharmacogenomics and ecogenomics
4. Epigenetic memory and imprinting
5. Programmed DNA rearrangements
6. Genetic basis of sex determination
7. Regulation of gene expression

7.1 Transcriptional regulation: nuclear architecture, chromatin remodeling, non coding RNA, micro-RNA network

7.2 Post transcriptional regulation: Splicing, alternative splicing, trans-splicing, RNA editing, mRNA stability

7.3 Post translational processing: Protein folding and molecular chaperons, protein processing, protein degradation

8. Gene function analysis
   8.1 Random mutagenesis, mutation screens, complementation and suppression
   8.2 Manipulation of genes, site-specific mutagenesis, transgenesis
   8.3 Targetted mutagenesis, gene knockout and gene knock-in methods
   8.4 Reporter genes and temporal/site specific expression
   8.5 RNAi and specific gene silencing
   8.6 Mitotic recombination and generation of somatic clones for developmental studies in *Drosophila*
   8.7 Nomenclature of gene mutations and chromosome rearrangements in *Drosophila*; balancer chromosomes

Suggested Readings:
1. Brown, 2007, Genomes, Bios.
2. Connors & Smith, 1994, Essentials of Medical Genetics, Blackwell.
3. Glick & Pasternak, 1994, Molecular Biotechnology, ASM Press
4. Gregory, 2006, The Evolution of the Genome, Elsevier.
5. Hartl, 2006, Essential Genetics: A Genomic Perspective, Jones Blackett.
6. Howley & Mori, 1999, The Human Genome, Academic.
7. Jorde et al., 2003, Medical Genetics, Elsevier.
8. Lewin, 2011, Genes X, Jones & Barlett
9. Primrose & Twyman, 2006 Principles of Gene manipulation and Genomics, Blackwel.
10. Sambrook et al., 2001, Molecular Cloning, vols 1-3 , CSHL Press.
11. Strachan & Read, 2011, Human Molecular Genetics, Wiley.
12. Watson et al., 2004, Molecular Biology of the Gene, Pearson Education.

ZOPR-08: Insect Physiology   Credits: 3

1. Digestive system
   1.1 Digestion of various types of food
   1.2 Absorption
2. Fat body: Structure and function
3. Excretory system
   3.1 Organs of excretion
   3.2 Nitrogenous excretion
        3.2.1 Excretory products
        3.2.2 Storage excretion
   3.3 Production of urine and its hormonal regulation
        3.3.1 Terrestrial and salt water insects
        3.3.2 Control of diuresis
        3.3.3 Water regulation
        3.3.4 Detoxification
4. Circulatory system
   4.1 Haemocytes
        4.1.1 Type
        4.1.2 Origin and longevity
        4.1.3 Haemopoietic organs
        4.1.4 Changes in haemocyte population
   4.3 Immunity
        4.3.1 Cell mediated immunity
        4.3.2 Humoral immunity
   4.4. Haemolymph proteins
        4.4.1 Storage proteins: synthesis, uptake and their role

4.4.2 Vitellogenin and its receptor mediated uptake by ovary
4.4.3 Antibacterial proteins
4.4.4 Lectins
4.4.5 Protease inhibitors
4.4.6 Enzymes in haemolymph
4.4.7 Peptides: neuropeptides and humoral factors
4.4.8 Chromoproteins
4.4.9 Specific transport proteins
5. Reproduction
   5.1 Reproductive organs
   5.2 Gametogenesis

Suggested Readings:
1. Advances in Insect Physiology, 1986-2001, Vols. 1-28, Academic Press
2. Chapman, 1998, The Insects: Structure and Function, 4th edition, ELBS
3. Gilbert et al. , 2005: Comprehensive Molecular Insect Science, Volume 1- 7, Elsevier
4. Gillot,1995, Entomology, 2nd edition, Plenum Press
5. Gullan & Cranston, 2000, The Insects: An Outline of Entomology, 2nd edition, Blackwell
6. Gupta, 1979, Insect Hemocytes, Cambridge University Press
7. Imms, 1997, A General Text Book of Entomology, 2 volumes, Asia Publishing House
8. Kerkut and Gilbert, 1985, Comprehensive Insect Physiology, Biochemistry and Pharmacology, Voumes 1-13, Pergamon
9. Klowden, 2002, Physiological Systems in Insects, Academic Press
10. McGavin, 2001, Essential Entomology, Oxford Univ. Press
11. Rockstein, 1978, Biochemistry of Insects, Academic Press
12. Wigglesworth, 1972, Principles of Insect Physiology, ELBS

ZOPR-09: Recent Trends in Biochemistry-I   Credits: 3

1**. Nucleic Acids**
1.1. Analysis of chromatin organization
1.2. Promoter analysis and characterization
1.3. Post-transcriptional regulation
1.4. Epigenetic regulation of gene expression
2. **Proteins**
2.1. Purification and characterization of proteins
2.2. Structure-function relationship
2.3. Proteins of immune system and their applications
2.4. Receptors and cell signaling
3. **Enzymology**
3.1. Applications of enzyme kinetics
3.2. Enzyme distribution, diversity and evolution
3.3. Principles and applications of enzyme assay
3.4. Enzyme technology

Suggested Readings:
1. Watson et al. , 2008, Molecular Biology of the Gene,6th Edition, Cold Spring Harbor
2. Brown, 2006, Genomes, 3rd Edition, Garland Science)
3. Krebs et al, 2011, Lewin's Gene X , Jones & Bartlett
4. Lodish et al, 2008, Molecular Cell Biology, 6th Edition, Freeman
5. Sambrook & Russel, 2001, Molecular Cloning: A Laboratory Manual, 3rd Edition, Cold Spring Harbor.
6. Zubay et al, 1998, Biochemistry, 4th Edition, WCB.

7. Voet & Voet, 2004, Biochemistry, 4th Edition, John Wiley.
8 Berg et al., Biochemistry, 6th Edition, Freeman.
9. Rawn, 1989, Biochemistry, Neil Patterson.
10. Kindt et al., 2007, Kuby's Immunology, 6th Edition, Freeman
11. Price & Stevens, 1988, Fundamentals of Enzymology, 2nd Edition, Oxford.
12. Engel, 1981, Enzyme Kinetics: The steady state approach, Chapman & Hall.
13. Fersht, 1985, Enzyme Structure and Mechanisms, Freeman.

ZOPR-10: Recent Trends in Biochemistry-II   Credits: 3

1. Basic concept of metabolic Regulation
1.1. Concept of metabolic energy transduction
1.2. Regulatory mechanisms of major metabolic pathways and their significance
2. Neurochemistry of aging and brain disorders
2.1. Chemical basis of neuronal function
2.2. Neurochemical alterations during brain aging
2.3. Neurochemical basis of brain disorders
2.4. Genetic susceptibility of brain disorders
3. Learning and memory
3.1. Molecular mechanism of learning and memory
3.2. Effect of age on learning and memory
3.3. Molecular alterations during memory related disorders
4. Biochemical basis of cancer
4.1. Basic mechanism of carcinogenesis
4.2. Biochemical alterations during carcinogenesis
4.3. Regulatory mechanisms as targets for cancer therapy
5. Biochemical adaptations
5.1**.** Concept of homeostasis, stress and strain and their biochemical responses
5.2. Acclimation, acclimatization and adaptation
5.3. Metabolic alterations for short term adaptations
5.4. Genetic basis of evolutionary adaptations

Suggested Readings:
1. Nelson et al, 2007, Lehninger's Principles of Biochemistry, 5th Edition, MacMillan Worth
2. Zubay et al, 1998, Biochemistry, 4th Edition, WCB
3. Voet & Voet, 2004, Biochemistry, 4th Edition, John Wiley
   Kanungo, 1980, Biochemistry of Aging, Academic Press
5. Eric Kandel, 2000, Principles of Neural Science, Mc Graw Hill
6. Squir et al, 2003, Fundamental Neuroscience, Academic Press
7. Guyton & Hall, 2006, Text Book of Medical Physiology, 11 Editions, W.B. Saunders
8. Pecorino, 2008, Molecular Biology of Cancer: Mechanisms, Targets and Therapeutics, Oxford Univ. press
9. Wang, 2010, Cancer Systems Biology, CRC Press
10. Hochachka & Somero, 2002, Biochemical Adaptation – Mechanism and Process in Physiological Evolution, Oxford Univ. Press

ZOPR-11: Preparation of Research Plan Proposal (Write up) & Presentation and Defense   Credits: 2

ZOPR-12: Review of literature, submission of a report and presentation of a seminar on a research-theme related topic duly approved by the concerned RPC   Credits: 2