Common Ph.D. Course work for Science subjects other than Mathematics, Statistics, computer science and hospitality studies

The course work for Ph. D. will have total 18 credits of minimum six months duration.

1. Each learner after having been admitted to the Ph.D. degree programme, shall be required to undertake course work for a minimum period of one semester. The course work shall be treated as pre-Ph.D. preparation.
2. The Ph.D. course work shall be offered with credit system. The entire course work will have total 18 credits. The learner will have to earn 18 credits in maximum of three semesters.

Paper	Title	Max. credits
Paper I (DS??101)	Research Methodology and computer applications	6
Paper II (DS??102)	Active Participation and academic development.	6
Paper III (DS??103	Based on core subject*	6

4. Each Course shall be of 6 Credits.

5. Course work will be handled by concerned guide/s.

6. There may not be any formal classroom teaching however proportionate remission shall be given to the concerned teacher/s involved in guiding, as may be sanctioned by the competent authority from time to time.

7. Mode of study and evaluation for courses:

i) The continuous assessment of all the theory courses of PhD course work shall be done by the concerned and appropriate faculty of the research centre. The internal assessment will have 40% weightage and external assessment will have 60% weightage. It may include assignments/class tests/case studies or seminar

ii) The external assessment shall be by assigning the topic to learner for the seminar, Wherein the learner's contribution in collecting reference material, understanding the topic of the seminar work will have 30% weightage, presentation of the seminar and ability to answer the questions will have 50% weightage and punctuality, enthusiasm and aptitude of the student in preparing the seminar, writing the report will have 20% weightage. This will be evaluated by the concerned teacher/teachers.

8. Paper II (Course 2) which shall be executed during the Ph. D. work carrying max. 6 credits to be completed from amongst the following:

i) One poster/paper/presentation either from the thesis or otherwise, at national or international conference: 2 credits per paper (Maximum 4 credits)

ii) Attending workshops cummulative7 days duration: 2 credits (Max. 2 credits)

iii) Training in the laboratory outside the department/field work at least for a week: 2 credits. (Max. 2 credits)

iv) Two Seminars/presentations given on a topic other than the main topic of Research, which is attended by the faculty: 2 credits. (Max. 2 credits)

v) Member of the Organizing Committee of workshop/seminar/conference at state/national or international level: 2credits. (Max. 2 credits)

9. Course III shall be based on core subject.

10. The record of the evaluation is to be maintained till the learner clears his/her PhD degree from the university.

11. Seven point scale will be followed for assigning the final grade. Learner should get minimum 'C ' grade to qualify.

12. After completion of the course work guiding teacher will submit the certificate of completion of course work to the university in the prescribed format:

Name of the research centre

Certificate

This is to certify that Mr/Ms/Mrs…(Surname) ……(First name) ……(Second name)……. has been a regular student of Ph.D. with registration number …….. He/She attended the course work conducted at the recognized research centre/department from …… to …… during the year …… He/She has successfully completed the Ph.D. course work prescribed by the University of Mumbai. He/She secured ……. grade in seven point scale.

Date: Guiding teacher Head of the Department/principal

Seal Name: Name:

University of Mumbai:

Course1: Research Methodology and computer applications

Paper I: Research Methodology and Computational Applications (80 hrs) 6 Credits

Section I: Research Methodology

Unit I: Scientific Research: Research: Definition, Characteristics, types, need of research. Identification of the problem, assessing the status of the problem, formulating the objectives, preparing design (experimental or otherwise), Actual investigation, Determining the mode of attack.

Unit II: Literature survey: References, Abstraction of a research paper, Possible ways of getting oneself abreast of current literature.

Unit III: Documentation and scientific writing: Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing.

Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography.

Section II: Computer applications:

Unit iv: Use of word processing, spreadsheet and database software. Plotting of graphs. Internet and its application**:** E-mail, WWW, Web browsing, acquiring technical skills, drawing inferences from data,

Unit v: Statistical analysis and fitting of data : Introduction to Statistics – Probability Theories - Conditional Probability, Poisson Distribution, Binomial Distribution and Properties of Normal Distributions, Estimates of Means and Proportions; Chi-Square Test, Association of Attributes - t-Test –Anova- Standard deviation - Co-efficient of variations. Co-relation and Regression Analysis.

Unit vi: Data Analysis: Mathematical and statistical analysis using software tools like MAT Lab, SPSS, PsiLAB or free ware tools.

Main References:

1. Thesis & Assignment Writing–J Anderson, B.H.Dursten & M.Poole, Wiley Eastern, 1977
2. A Hand Book of Methodology of Research – P. Rajammal and P. Devadoss, R. M. M. Vidya Press, 1976.
3. The Craft of Scientific Writing by Michael Alley, (Springer).
4. Research Methodology by R. Panneerselvam, PHI, New Delhi 2005

5. Practical Research Methods, by Dawson, Catherine, 2002, UBS Publishers' Distributors New Delhi.
6. Research Methodology- A step by step Guide for Beginners, (2nd ed.) Kumar Ranjit, 2005, Pearson Education.
7. How to write and Publish by Robert A. Day and Barbara Gastel, (Cambridge University Press).
8. Survival skills for Scientists by Federico Rosei and Tudor Johnson, (Imperial College Press).
9. How to Research by Loraine Blaxter, Christina Hughes and Malcum Tight, (Viva Books).
10. The Craft of Scientific Writing by Michael Alley, (Springer).
11. A Student's Guide to Methodology by Peter Clough and Cathy Nutbrown, (Sage Publications).
12. Probability and Statistics for Engineers and Scientists" by Sheldon Ross, (Elsevier Academic Press).
13. Research methodology techniques and methods by C L Kothari, New age International publishers.

Ph. D Course work in Physics

The course work for Ph. D. will have total 18 credits of minimum six months duration.

1. Each learner after having been admitted to the Ph.D. degree programme, shall be required to undertake course work for a minimum period of one semester. The course work shall be treated as pre-Ph.D. preparation.
2. The Ph.D. course work shall be offered with credit system. The entire course work will have total 18 credits. The learner will have to earn 18 credits in maximum of three semesters.

Paper	Title	Max. credits
Paper I (DSPH101)	Research Methodology and computer applications	6
Paper II (DSPH102)	Active Participation and academic development.	6
Paper III (DSPH103	Based on core subject*	6

Subject code 'PH'

4. Each Course shall be of 6 Credits.

5. Course work will be handled by concerned guide/s.

6. There shall not be any formal classroom teaching however proportionate remission shall be given to the concerned teacher/s involved in guiding, as may be sanctioned by the competent authority from time to time.

7. Mode of study and evaluation for courses:

i) The continuous assessment of all the theory courses of PhD course work shall be done by the concerned and appropriate faculty of the research centre. The internal assessment will have 40% weightage and external assessment will have 60% weightage. It may include assignments/class tests/case studies or seminar

ii) The external assessment shall be by assigning the topic to learner for the seminar, Wherein the learner's contribution in collecting reference material, understanding the topic of the seminar work will have 30% weightage, presentation of the seminar and ability to answer the questions will have 50% weightage and punctuality, enthusiasm and aptitude of the student in preparing the seminar, writing the report will have 20% weightage. This will be evaluated by the concerned teacher/teachers.

8. **Course II**: which shall be executed during the Ph. D. work carrying max. 6 credits to be completed from amongst the following:

i) One poster/paper/presentation either from the thesis or otherwise, at national or international conference: 2 credits per paper (Maximum 4 credits)

ii) Attending workshops cummulative7 days duration: 2 credits (Max. 2 credits)

iii) Training in the laboratory outside the department/field work at least for a week: 2 credits. (Max. 2 credits)

iv) Two Seminars/presentations given on a topic other than the main topic of Research, which is attended by the faculty: 2 credits. (Max. 2 credits)

v) Member of the Organizing Committee of workshop/seminar/conference at state/national or international level: 2credits. (Max. 2 credits)

9. Course III

1. **Course III** shall be based on core subject. Eleven Modules are offered (given overleaf) out of which the guide will ask the student to carry out course work any one module. Evaluation will be as given in item 7 i) and ii)
2. The record of the evaluation is to be maintained till the learner is awarded his/her PhD degree by the university
3. Seven point scale will be followed for assigning the final grade. Learner should get minimum 'C' grade to qualify
4. After completion of the course work the Research Centre, will submit the certificate of completion of course work to the university.

Course III

Any One module to be completed out of the following:-

Module 1 : Basic Measurements

1) **Evaluation of Measurements**: Errors; Normal, Binomial and Poisson distribution; Least square fit; Curve, fitting, Polynomials; Chi-square test.

2) **Length and Related Quantities:** Rutherford Experiment (Nuclear Size); X-ray, Electron and Neutron diffraction (Atomic size).

3) **Voltage, Current and Charge Measurements**

4) **Magnetic Field**: Magnetic Materials; Production and Measurement of Magnetic Fields.

5) **Temperature:** Production and Measurement of High and Low Temperatures, High temperature materials.

Main References:

1. "Errors of Observation and their Treatment" by J. Topping, Chapman of Hall, London 1972.
2. B.D. Cullity, Elements of X-ray diffraction", Addison-Wesley Publishing company inc., 1977.
3. "Methods of Experimental Physics Vol. 2" by L. Marton (ed), Academic Press, New York, 1981.
4. "Introduction to Magnetic Materials" by B. D. Cullity, Addison Wesley Publishing Company, 1974.

5. "Temperature" by T. J. Quinn, Academic Press, London, 1983.

Module 2: Experimental Methods

1. **Vacuum Technology:** Production and Measurement of Rough to Ultra High Vacuum; Design of vacuum systems; Leak detection methods, Vacuum Materials.
2. **Thin Film Technology:** Synthesis of thin films for research and technological applications.
3. **Ion Beam Techniques:** Synthesis, Modification and Processing of novel Materials; Ion beam analysis- SIMS, RBS, Channeling, ERDA.
4. **Modern Analytical Tools:** AES, XPS, TEM, SEM, FTIR spectroscopy, Raman spectroscopy, ESR, PL, STM, AFM.
5. **Great Experiments in physics:** Any two great experiments suggested by the teacher concerned not covered in the syllabus.

Main References:

1. "Vacuum Technology" by A. Roth, North Holland, Amsterdam, 1982.
2. K.L. Chopra, Thin film phenomena, Mc-Graw Hill, New York, 1969.
3. "Ion Implantation" by G. Dearnaley, J. H. Freeman, R. S. Nelson,. and J. Stephen, North-Holland, Amsterdam, 1973.
4. L. C. Feldman and J.W. Mayer, Fundamentals of surface and Thin Films Analysis, North Holland, Amsterdam, 1986.
5. Great Experiments in Physics, M. H. Shamos, Dover Publication, 1987

Module 3: Semiconductor Physics

1. **Crystal structure and Band structure:** Study of crystal structure and band structure of silicon, germanium and gallium arsenide semiconductors.
2. **Properties of Semiconductors:** Charge carriers in semiconductors, Hall Effect; Magneto resistance; Hot carriers; Quantum Hall effect. Thermal effects in semiconductors, Fundamental, impurity, free carrier and exciton absorption. Radiative and surface

recombination. Photoconductivity. Optical processes in quantum wells; Laser action in semiconductors.

3. **Advanced and Novel Electronic Materials:** Amorphous Si, Ge and GaAs, Organic semiconductors, Spintronics materials, Dilute magnetic semiconductors; Semiconductor quantum wells, quantum wires and quantum dots; Semiconductor nanocrystals.
4. **Surfaces and Interfaces:** Surface states, Interface states in semiconductor devices; Characterization of semiconductors and devices by I-V, C-V, G-V and DLTS techniques.
5. **Ultra Large Scale Integrated circuit (ULSI) device technology:** Semiconductor bulk crystal Growth, Epitaxy, defects, dislocations and doping in semiconductors, Basic device fabrication processes, Circuit design and fabrication.

Main References:

1. R.A. Smith, Semiconductors, 2nd edition; Cambridge University Press, London, 1978.
2. Jasprit Singh, Physics of Semiconductors and their Heterostructures, McGraw-Hill, New York, 1993,
3. M.H. Brodsky (ed), Topics in Applied Physics Vol.36, Amorphous Semiconductors,
4. S.R. Elliott, Physics of Amorphous Materials, Longman, London, 1983,
5. E.L. Wolf, Nanophysics and Nanotechnology, Wiley-VCH Verlag, Weinheim, 2004.
6. S.M. Sze, Physics of Semiconductor Devices, John Wiley, N.Y., 1981,
7. E..H. Nicollian an J.R. Brews, MOS Physics and Technology, John Wiley, 1982,
8. S.M. Sze, Semiconductor Devices-Physics and Technology, John Wiley, 1985

Module 4. Modern Electronics

1. **Microcontroller:** Introduction to microcontroller, 8051 microcontroller, MCS –51 Architecture, Registers, 8051 pin description, Connections, I/O ports, Memory organization, Addressing modes, Instruction set, Stack pointer, 8051 Assembly language programming, Development systems and Tools, Software simulator of 8051, Interrupts, Timer and Counter, Serial communication, Atmel microcontrollers (89C51 / 89C2051), Architectural overview, Pin description (89C51 / 89C2051), Applications of MCS – 51 and 89C51 / 89C2051, PIC microcontroller – overview, Memory organization and

Instructions, Addressing modes, I/O ports, Interrupts in PIC 16C61/71, PIC 16C61/71 timers, PIC 16C61/71 – ADC, PIC 16F8XX flash microcontroller, Interfacing and microcontroller applications, Industrial applications of microcontrollers.

2. **VHDL:** Basic terms in VHDL, Behavioral modeling, Types of delay, Sequential processing, Data types, Function and Procedure, Attributes, Configurations
3. **Embedded system:** Introduction to embedded system, Design challenges, Optimizing design metrics, Processor design and IC technology, Embedded system project management, Embedded system design and co-design isues in system development process, Design cycle in the development phase for an embedded system. Use of software tool for development of embedded system PC interfacing: Study of PC parallel port: Essentials, Accessing ports, Programming issues, Programming tools, Experiments and interfacing, Study of PC serial port: Format and Protocol, Sending serial Data, Transmitting a byte, Data Formats, Preventing missed data, Port architecture, Port resources, Configuring inside the UART.

Main References:

1. Microcontrollers – Theory and Applications, Ajay V Deshmukh. Ch. 1 to 10, 12,13.
2. VHDL Programming by example, Douglas L. Perry. Ch. 1 to 7.
3. Embedded system design – a unified hardware, software introduction Frank Vahid and Tony Givargis Ch.1.
4. Embedded system design – Raj Kamal. Ch. 12.1 to 12.3, 12.5
5. Parallel port complete – Jan Axelson. Ch. 1 to 6
6. Serial port complete -- Jan Axelson. Ch. 2,3

Module 5. Nanotechnology

1. Fundamentals of nanomaterials and nonostructures
2. Synthesis of nanoparticles, nanoclusters, nanocrystals; top-up approach and bottom-up approach, Self-Assembly.
3. Properties of Metal Nanoclusters, Semiconducting Nanoparticles, Rare Gas and Molecular Clusters and Nanotubes.
4. Characterization of nanomaterials and nanostructures: structure, particle size, distribution.
5. Applications of nanotechnology in Semiconductor devices, Energy, Sensors, Coatings.

Main References:

1. Introduction to Nanotechnology, C. P. Poole and F. J. Owens Pub Wiley & Sons, 2006
2. Nanostructures & Nanomaterials, Synthesis Properties & Applicatios, G. Cao, Imperial Press 2006
3. Springer Handbook of Nanotechnology, Bharat Bhusan, 2004

Module 6. Accelerator Physics

1. Introduction to Accelerators; Types of Accelerators**:** High voltage dc and r. f. accelerators, Cyclotron, Betatron , Synchrotron and Linear accelerators, Van de Graaff generator, Tandem accelerator, Pelletron accelerator.
2. Ion Sources: Freemen ion beam source, Penning ion source, Sputtered ion source, Duoplasmatron ion source, Negative ion beam sources, Electron Cyclotron Resonance (ECR) ion beam sources, LASER ion source. Beam switch yard: conventional magnet and superconducting magnet Beam optics, Beam profile monitor, Faraday cup, Quadrupole. Accelerator driven systems: Injection and extraction,Vacuum systems.
3. Application of accelerators: Ion implantation, Surface modifications and research, Materials analysis, Nuclear physics, High energy Physics studies, Production of medical isotopes, Radiotherapy, Radiation and Safety.

Main References:

1. S Y Lee, Accelerator Physics, [World Scientific 1999]
2. Edmund Wilson, An Introduction to Particle Accelerators, [Oxford University Press 2001]
3. Alex Chao, Handbook of Accelerator Physics and Engineering [World Scientific 1999]
4. Mario Conte and William W McKay, An Introduction to the Physics of Particle Accelerators, [World Scientific 1991]
5. Ashok Das and Thomas Ferbel, Introduction to Nuclear and Particle Physics [John Willey 1994]
6. J.F. Ziegler, Ion Implantation Science and Technology,

7. G. Dearnaley, J.H. Freeman, R.S. Nelson, and J. Stephen, Ion implantation, North Holland, Amsterdam 1973.

Module 7. Nuclear Physics

1 Nuclear Structure: Problem of Nucleon –Nucleon Interactions and Nuclear Forces, Nuclear Models and Nuclear Matter, Electromagnetic and Weak Interactions with Nuclei.

2 Nuclear Reactions: Formal theory of Scattering and Nuclear Reaction Mechanisms, Compound Nuclear Reactions, Optical Model and Direct Nuclear Reactions, Nuclear Reactions at Intermediate and High Energies.

3 Methods in Experimental Nuclear Physics

Main References:

1. Nuclear structure, M. A Preston and R. K. Bhandhuri, Addition – Wesley (1975).

2. Nuclear Physics: R. Roy and B. Nigam – Wiley Eastern Ltd. (1979).

3. Fundamentals of Nuclear Physics – N. A. Jelly, Cambridge University Press.

4. Introductory Nuclear Physics – Samuel S. M. Wong, Prentice Hall of India(1996).

5. Nuclear models, Greiner and Maruhn: Springer Verlag.

6. Nuclear Reactions—Daphne F. Jackson ,Chapman and Hall.

7. Nuclear and Particles – E. Segre

8. Nuclear Physics, HA Enge

9. Techniques for Nuclear and Particle Physics Experiments, W.R.Leo, Springer – Verlag, II edition.

Module 8. Laser and Plasma Physics

1. **Fundamentals of Laser:** Laser Raman Spectroscopy, Holography, New Developments in Spectroscopy, Applications.

2. **Fundamentals of Plasma:** Mangnetohydrodynamics (MHD), Space Plasma Physics, Transport properties in Plasma, Applications.

Main References:

1. Lasers: Theory & Applications, A.K.Ghatak
2. Optoelectronics Devices & Systems, S.C.Gupta
3. Space Plasma Physics, A.C.Das
4. Laser Spectroscopy, W.Demtroder(Springer)
5. Intoduction to Plasma Physics & Controlled Fusion, F.F.Chen
6. The Physics of Laser & Plasma Interactions, W.L.Kruer
7. Industrial Plasma Engineering, J.Reece,Roth
8. Introduction to Plasma Theory, D.R.Nichalson
9. Plasma Physics, R.Dendy

Module 9. Materials Science

1. ***Introduction to Materials Science:*** Classification of Materials, Functional Classification of Materials, Classification of Materials Based on Structure, Environmental and Other Effects, Materials Design and Selection.
2. ***Atom and Ion Movements in Materials:*** Applications of Diffusion, Stability of Atoms and Ions, Mechanisms for Diffusion, Activation Energy for Diffusion, Rate of Diffusion (Fick's First Law), Factors Affecting Diffusion, Permeability of Polymers, Composition Profile (Fick's Second Law), Diffusion and Materials Processing. Chemical Equilibrium, Rate of Reaction, First and Second order Phase Transformation, Order-Disorder Transformation, Solid State Sintering.
3. ***Solid Solutions and Phase Equilibrium:*** Phases and the Phase Diagram, Solubility and Solid Solutions, Conditions for Unlimited Solid Solubility, Solid-Solution Strengthening, Isomorphous Phase Diagrams, Relationship Between Properties and the Phase Diagram, Solidification of a Solid-solution Alloy, Nonequilibrium Solidification and Segregation, Nucleation and Rate of Phase Transformation

Main References:

1. The Science and Engineering of Materials, 5th ed, Donald R. Askeland and Pradeep P. Phulé, Thomson Learning 2006.

2. Science of Materials Engineering, 2nd Edition, C. M. Srivastava and C. Srinivasan, (New Age International), 2005

Module 10. Condensed Matter Physics

1. **Physical applications of Group theory in crystals:** Theory of group representation, crystal symmetry operators; Crystallographic point groups. Representation of three dimensional rotation group. Crystal field splitting and other related problems.
2. **Elastic Scattering of waves**: Interference of Waves, Elastic scattering by Crystals, Experimental Techniques, Scattering from surfaces, Scattering from amorphous solids
3. **Magnetic Properties:** Background, Diamagnetism and Para magnetism, Ferromagnetism, Ferri and anti ferromagnetism, Spin waves, Magnetic resonance Phenomenon

Main References:

1. M. Tinkham, Group Theory and Quantum Mechanics, Dover Publications, 2003
2. N.W.Ashcroft and N.D. Mermin, Solid State Physics, Brooks Cole, 1976
3. J. Richard Christman, Solid State Physics, John Wiley, 1988

Module 11. Theoretical Physics

This paper is envisaged as applications of Quantum Mechanics to physical systems through problems:

1. Formalism in quantum mechanics,
2. Time dependent perturbation theory,
3. Relativistic Quantum Mechanics,
4. Scattering Theory

Main References:

1. Richard Liboff, *Introductory Quantum Mechanics*, 4th ed., 2003.
2. Ajoy Ghatak and S Lokanathan, *Quantum Mechanics: Theory and Applications*, 5th ed., 2004. (GL5)

3. W. Greiner, *Quantum Mechanics: An Introduction*, 2nd ed., 2001.
4. R. Shankar, *Principles of Quantum Mechanics*, 2nd ed., 1994
5. L.I.Schiff, *Quantum Mechanics*, 1968
6. Claude Cohen - Tannoudji, Bernard Diu, Frank Laloe, *Quantum Mechanics* Vol I and II, 1977
7. C.S. Johnson and Pederson, *Problems and solutions in Quantum Chemistry and Physics,* 1974
8. S. Flugge, *Practical Quantum mechanics*, 1971
9. W. Greiner, *Relativistic Quantum Mechanics*, 2nd Ed.,2001
10. J.J. Sakurai, Advanced Quantum Mechanics, Addison Wesley, 1967

Name of the research centre

Certificate

This is to certify that Mr/Ms/Mrs…(Surname) ……(First name) ……(Second name)……. has been a regular student of Ph.D. with registration number …….. He/She attended the course work conducted at this recognized research centre/department from …… to …… during the year …… He/She has successfully completed the Ph.D. course work prescribed by the University of Mumbai. He/She secured ……. grade in seven point scale.

Date: Guiding teacher Head of the Department/principal

Seal Name: Name:

Pre-Ph.D. / M. Phil. Statistics
Coursework

Paper – I (Research Methodology)(6 credit course)

Semester – I (3 Credits)

Unit-I: Mathematical Analysis -I

Unit-II: C/C++, R and LaTeX -I

Unit – III: Simulation studies-I

Semester – II (3 Credits)

Unit-I: Mathematical Analysis – II

Unit-II: C/C++, R and LaTeX (Statistics) – II

Unit – III: Simulation studies –II

References:

1.Morgan,B.J.T.(1995).Elements of Simulation.CHAPMAN &HALL
2.Goldberd, R. R.(1975): Methods of Real Analysis
3.Aliprantis,C. D. and Burkinshaw,Owen(1998); Principles of Real Analysis
4. Rudin, Walter (1980): Principles of Mathematical Analysis
5. Fahller,Bjorn (2001): An introduction to C++

Paper II: Probability and Inference (6 credit course)

Semester-I(3 Credits)

Unit I: Probability theory: Independence, Borel-Cantelli Lemma, Kolmogorov's zero-one law, law of large numbers, conditional probability and conditional expectation, martingales.

Unit-II: Characteristic function, Laws of Large numbers
Unit-III: Modes of Convergence ,Consistency, Central limit theorems under various conditions

Semester-II(3 Credits)

Unit –I: UMVUE in Non-Exponential family, Lower Bounds for the variance of an estimate

Unit-II: Parametric Tests
Unit-III: Nonparametric tests

References:

1. David Roxbee Cox& David Victor Hinkley (1982). Theoretical statistics Chapman and Hall
2. Shao Jun (2003). Mathematical Statistics. 2nd Edition, Springer
3. Ripley, Brian D. (1987). Stochastic simulation. WILEY-INTERSCIENCE PAPERBACK SERIES
4. Van der Vaart, A. W. (1998) . Asymptotic Statistics. Cambridge: Cambridge University Press.
5. Tanner, M. A. (1996): Tools for statistical inference. Springer
6. Larry Wasserman (2004). All of Statistics. Springer.
7. Bhat, B.R. (1991).Modern Probability Theory. WILEY EASTERN LIMITED
8. Lehmann, E.L. (1990). Testing statistical hypothesis (2nd ed.). New York: Wiley.
9. Zacks,S.(1971): The theory of Statistical Inference, Wiley.

Paper III : Reading paper (6 credit course)

This paper will be assigned by the research guide covering the research topic. Grading of this course will be done by the research guide and one examiner appointed by the departmental research committee.

EXAMINATION PATTERN

R.1 : There will be 100 marks Examination for Paper I and II at the end of each semester.

STANDARD OF PASSING

R.2 : A candidate securing a minimum of 40% marks in each paper will be declared to have passed in that paper and will be exempted from that paper.
R.3 : The Research Guide and the examiner should unanimously that candidate is successful or not by recommending as pass or fail.
R.4 : A candidate will be declared to have pass the Ph.D course work if he or she passes in all three papers.

Appendix I

UNIVERSITY OF MUMBAI

SYLLABUS FOR M.PHIL. / PRE-PH.D. COURSEWORK IN COMPUTER SCIENCE

(To be implemented w.e.f. academic year 2011-12)

Objective of the M.Phil. / Pre-Ph.D. Course: To organize a path leading to successful research work in Computer Science. The intention is to introduce the candidate to (1) the deep foundations of core computing and research methodology, (2) current trends in the rapidly evolving field and (3) the intellectual and philosophical framework necessary to explore wide spectrum of research in computing and prepare the student to start the M.Phil. / Ph.D. research project.

The three M.Phil. / Pre-Ph.D. papers which broadly cover these aims are:

(1) Paper – I Research Methodology

(2) Paper – II Recent Advances in the core areas

(3) Paper – III Elective

Each of the papers will be taught over two semesters and for the 6 credits. Teaching and evaluation would be as per the guidelines suggested by the University of Mumbai.

Paper - I: Research Methodology

Semester - I

Unit I: Mathematical Foundations, Science of Programming – I (1 credit)

Unit II: Design and Analysis of Algorithms, Programming paradigms – I (1 credit)

Unit III: Modeling, Programming, Methodology and Documentation practices – I (1 credit)

Semester - II

Unit IV: Mathematical Foundations, Science of Programming – II (1 credit)

Unit V: Design and Analysis of Algorithms, Programming paradigms – II (1 credit)

Unit VI: Modeling, Programming, Methodology and Documentation practices – II (1 credit)

Recommended texts:

1. T.H. Cormen, Introduction to Algorithms, MIT Press

2. E.W. Dijkstra and C.S. Schoelten, Predicate calculus and program semantics, Springer-Verlag
3. G. Dromey, Program derivation: The development of programs from specifications, Addison-Wesley
4. D. Gries, The Science of Programming, Springer
5. D. Gries and F.B. Schneider, A logical approach to discrete math, Springer
6. D.E. Knuth, The Art of Computer Programming (Vol. 1 to 4), Addison-Wesley
7. B.J. Oastes, Researching Information Systems and Computing, Sage
8. J.M. Spivey, Understanding Z: A specification language and its formal semantics, Cambridge University Press

Paper - II: Recent Advances in the Core Areas

Semester–I

Unit I: Artificial Intelligence and Software Architecture – I (1 credit)
History, evolution and futuristic trends - Classical and Modern approach, application domain specific requirements, Case studies.

Unit II: Database Management and Information security – I (1 credit)
Acquisition, storage and handling of data, Design of data structures, files and data warehouses, Parallel and distributed databases, Maintaining integrity and security of information.

Unit III: Computer Architecture and Operating systems – I (1 credit)
Classical and modern views – Fundamental design principles and on-going research, Requirements of high performance computing, networked and mobile scenarios.

Semester – II

Unit IV: Artificial Intelligence and Software Architecture – II (1 credit)
History, evolution and futuristic trends - Classical and Modern approach, application domain specific requirements, Case studies.

Unit V: Database Management and Information security – II (1 credit)
Acquisition, storage and handling of data, Design of data structures, files and data warehouses, Parallel and distributed databases, Maintaining integrity and security of information.

Unit VI: Computer Architecture and Operating systems – II (1 credit)
Classical and modern views – Fundamental design principles and on-going research, Requirements of high performance computing; Networked and Mobile scenarios.

Note: The plan is to cover the basic concepts, some of the current trends and a related case study, in order to suggest possibilities about comparable research areas. The standard text books are available on each of the topics. The concerned teachers are to choose case studies or research papers and create a reading list.

Paper - III: Electives

Note: An exhaustive list of niche topics to form this paper cannot be prescribed in advance because the choice of topics will depend on the interests of both teachers and students. The list of topics and recommended reading material will be submitted to the concerned authorities, and their approvals obtained, within one month of the start of the M.Phil. / Pre-Ph.D. coursework.

Following list of 8 topics has been recommended for its implementation w.e.f. academic year 2010-11. Detail syllabus of each paper is given in the Appendix - A

Elective 1: Computational Intelligence
Elective 2: Knowledge Engineering
Elective 3: Modern Distributed Systems
Elective 4: **Algorithmic Game Theory and Artificial Intelligence**
Elective 5: Advanced course in DBMS
Elective 6: Advanced course in Artificial Intelligence
Elective 7: Advance course in Machine Learning
Elective 8: Advanced Spatial Database Systems

Appendix - A

Elective 1: Computational Intelligence

Unit 1: Overview of AI and Introduction to Computational Intelligence, Artificial Neural Networks – Artificial Neurons, Supervised and unsupervised learning, Radial Basis Networks, Reinforce learning. (1 credit)

Unit 2: Evolutionary Computation –Introduction, Genetic Algorithms, Evolutionary strategies, Differential Evolution, Cultural Algorithms, Co-evolution (1 credit)

Unit 3: Swarm Intelligence – Particle Swarm Optimization, Ant Colony Optimization, Bee Colony Optimization (1 credit)

Unit 4: Artificial immune systems (AIS) –Natural Immune Systems, AIS Architecture, AIS models. (1 credit)

Unit 5: Fuzzy Systems – Fuzzy sets, Fuzzy logic, Fuzzy controllers, Rough sets and Rough logic, Rough-Fuzzy computing, Granular computing. (1credit)

Unit 6: A case study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Recommended texts:

1. A. P Engelbrecht, Computational Intelligence: An Introduction, Wiley

Elective 2: Knowledge Engineering

Unit 1: Case study approach for data warehousing: transactions at Wal-Mart, complete client histories at an insurance firm, stockbroker financial information and portfolios, Research issues in query processing and optimization, database design and view management.

(1 credit)

Unit 2: Health services research data warehouse, data warehouse objectives – crate person-level view of data, construction of data extraction tools to support accessing data by chronic conditions, complex customized research data requests related to chronically illness, new formats for Medicare enrollment, claims and assessment data that support research. (1 credit)

Unit 3: Data Mining – Text mining, web mining, predictive data mining, discovery driven data mining, verification driven data mining, decision support technologies, Bioinformatics and pattern discovery, integration of data mining and information extraction.

(1 credit)

Unit 4: Knowledge Discovery Laboratory (KDL) – Investigating how to find useful patterns in large and complex databases, study of underlying principles of data analysis algorithms, developing innovative techniques for knowledge discovery, and their applications to practical tasks in areas such as fraud detection, scientific data analysis, and web mining, focuse on relational knowledge discovery.
(1 credit)

Unit 5: Constructing useful statistical models from data about complex relationships among people, places, things, and events. Social communication networks and their impact – the Web, telecommunications networks, relational databases, object-oriented databases, and other sources of structured and semi-structured data. (1 credit)

Unit 6: A case study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Elective 3: Modern Distributed Systems

Unit 1: Study of the implementations of distributed system principles in following modern distributed systems. Java RMI, Jini, CORBA, J2EE, .net, web services, BPEL, web services orchestration engines.

(1 credit)

Unit 2: Mobile computing, mobile agents, P2P, distributed multimedia systems. (1 credit)

Unit 3: Application of distributed computing in communication models, process implementations, naming, distributed file systems, global states. (1 credit)

Unit 4: Clock synchronization, coordination and agreement, transaction and concurrency control, Logical clocks, Global state, Election algorithms, Mutual exclusion, Distributed transactions.
(1 credit)

Unit 5: Consistency and Replication, Introduction, Data centric consistency models, Client centric consistency models, Distribution protocols, Consistency protocols, distributed shared memory, fault tolerance and security. (1 credit)

Unit 6: A case study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Elective 4: **Algorithmic Game Theory and Artificial Intelligence**

Unit 1: Problems, Problem Spaces and Search: Defining the problem as a state space search, Production Systems, Problem Characteristics, Production system characteristics, Issues in design of search problem, Problem Solving – Searching for solutions, uniformed search strategies, Heuristic Search Techniques – Generate-And-Test, Problem Reduction, Hill Climbing, Best-first search.
(1 credit)

Unit 2: Problem solving agents, Multi-agent and distributed systems for game theoretic problem solving – definition of distributed constraint satisfaction problems, domain-pruning algorithms, heuristic search algorithms, asynchronous backtracking algorithm (ABT), case study: the four queens problem, further developments. (1 credit)

Unit 3: Introduction to non-cooperative games – Self-interested agents, Preferences and utility, Games in normal form (definition and strategies), Analyzing games: from optimality to equilibrium, Pareto optimality, Defining best response and Nash equilibrium, Finding Nash equilibria, Nash's theorem: proving the existence of Nash equilibria, Further solution concepts for normal-form games, Max-min and min-max strategies, Min-max regret, Removal of dominated strategies, Rationalizability, Correlated, Trembling-hand perfect and □-Nash equilibriums. (1 credit)

Unit 4: Games with sequential actions: Reasoning and Computing with extensive forms – Perfect-information extensive-form games (Definition and Strategies and equilibria), Sub game-perfect equilibrium, Computing equilibria (backward induction), Imperfect-information extensive-form games (Definition and Strategies and equilibria), Computing equilibria: the sequence form, Sequential equilibrium. (1 credit)

Unit 5: Richer representations: Beyond the normal forms – Repeated games, Finitely repeated games, Infinitely repeated games, Stochastic games, Strategies and equilibria, Computing equilibria, Bayesian games, Strategies and equilibria, Computing equilibria, Ex post equilibrium, Congestion games, Computing equilibria, Potential games, Non-atomic congestion games.
(1 credit)

Unit 6: A case study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Recommended texts:

1. E. Rich, Artificial Intelligence, TMC
2. S. Russell, Artificial Intelligence: A Modern Approach, Pearson Education
3. Y. Shoham, Multiagents Systems
4. G. Weiss, Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, MIT Press, Cambridge
5. M.P. Wellman, A. Greenwald and P. Stone, Autonomous Bidding Agents: Strategies and Lessons from the Trading Agent Competition, MIT Press

6. M. Wooldridge, An introduction to multi agent systems (2nd ed.), Wiley

Elective 5: Advanced course in DBMS

Unit 1: Overview of Relational Databases, XML Data, XML validation, Relational Algebra, SQL (construction and modification of query) (1 credit)

Unit 2: Relational Design Theory (Functional dependencies, multivalued dependencies and, normalization), Querying XML. (1 credit)

Unit 3: UML, indexes. (1 credit)

Unit 4: Constraints and Triggers, Views, Authorization. (1 credit)

Unit 5: Transactions, Recursion, OLAP, NoSQL Systems (1 credit)

Unit 6: A case study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Recommended texts:

1. Elmasri and Navathe, Fundamentals of Database Systems (6th ed.), Pearson
2. Garcia-Molina, Ullman, and Widom, Database Systems: The Complete Book (2nd ed.), Prentice Hall
3. R. Ramakrishnan and J. Gehrke, Database Management Systems (3rd ed.), MGH
4. Silberschatz, Korth, and Sudarshan, Database System Concepts (6th ed.), MGH
5. Ullman and Widom, A First Course in Database Systems (3rd ed.), Pretice Hall

Elective 6: Advanced course in Artificial Intelligence

Unit 1: Overview of AI, Search, Uncertainty, and Bayes networks. (1 credit)

Unit 2: Hidden Markov models and Bayes filters, Markov Decision Processes and Reinforcement Learning. (1 credit)

Unit 3: Adversarial planning (games) and belief space planning (POMDPs)(1 credit)

Unit 4: Logic and Problem Solving, Robotics and robot motion planning. (1 credit)

Unit 5: Natural Language Processing and Information Retrieval. (1 credit)

Unit 6: A case study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Recommended texts:

1. S. Russel and P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall

Elective 7: Advance course in Machine Learning

Unit 1: Introduction to Machine Learning, Overview of linear algebra, Univariate linear regression, Multivariate linear regression. Practical aspects of implementation. Implementation in Octave.
(1 credit)

Unit 2: Logistic regression, One-vs-all, Regularization. Neural Networks, back propagation, gradient checking, Support Vector Machines (SVMs), Naive Bayes, Decision trees, Boosting algorithms (How to develop, debugging, feature/model design, setting up experiment structure).
(1 credit)

Unit 3: Unsupervised learning – Agglomerative clustering, K-means, PCA, ICA (when to use each), Anomaly detection. Combining supervised and unsupervised. (1 credit)

Unit 4: Other applications (Recommender, searching, ranking systems). (1 credit)

Unit 5: Design of large-scale/parallel machine learning systems. (1 credit)

Unit 6: A case study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Recommended texts:

1. N.J. Nilsson, Introduction to Machine learning (Lecture notes)

Elective 8: Advanced Spatial Database Systems

Unit 1: Introduction, What is GIS, Geo-Spatial Data, Geo relational Vector Data Model and Raster Data Model, Representation of features, Topology, Elements of Raster Data Model

Raster Data Structure. (1 credit)

Unit 2: Automated Spatial Data Acquisition, Direct measuring techniques (including GPS and total station based measurements). Indirect measuring techniques (including mobile mapping and airborne and satellite remote sensing). Automatic spatial map feature generation.
(1 credit)

Unit 3: Spatial Object Modeling and Database Generation, 2-D Spatial object modeling, 3-D Spatial object modeling, spatial database design and generation. (1 credit)

Unit 4: Spatial Relations and Algebra in Mapping and GIS, Review of relational operators, Relational algebra. Application in mapping and GIS, Normalization and conformation of spatial databases. (1 credit)

Unit 5: Map Related Spatial Data Access, Quality and Applications, Spatial indexing

Integrity constraints, Spatial topology and consistency, Distributed map related spatial databases, Spatial data mining and knowledge discovery. (1 credit)

Unit 6: Case Study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Recommended Texts:

1. Date, C.J. 1990. An Introduction to Database Systems. Addison-Wesley Publishing Company.
2. Samet, H. 1990. The Design and Analysis of Spatial Data Structures. Addison-Wesley Publishing Company, Inc. Reading, Massachusetts.
3. Raper, J. 1989. Three Dimensional Applications in Geographical Information Systems. Taylor & Francis.

Appendix - B

Following four new electives are offered with the immediate effect for its implementation.

Elective 9: Cryptography

Elective 10: Natural Language Processing

Elective 11: Probabilistic Graphical Models

Elective 12: Programming for robotics

Detail syllabi are given below.

Elective 9: Cryptography

Unit1: Cryptographic primitives, given a situation how to choose a correct technique, reasoning about the security of cryptographic constructions in theory and practice (1 credit)

Unit2: Peer-to-peer shared secrets, eavesdrops, traffic tampering, analysis of existing protocols (1 credit)

Unit3: Public-key cryptography, number theory for public-key encryption, digital signatures, and authentication protocols. (1 credit)

Unit4: Advanced topics in cryptography, namely, zero-knowledge, distributed protocols for secure auctions, privacy mechanisms. (1 credit)

Unit5: Open problems in Cryptography (1 credit)

Unit 6: Case Study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Recommended Texts:

1. A. Menezes, P. van. Oorschot, and S. Vanstone, *Handbook* of Applied *Cryptography*, CRC Press, 1996.

2. Niels, Schneier. Practical Cryptography, John Wiley & Sons, 2003.

3. Schneier Bruce. Applied Cryptography, John Wiley & Sons, 1996.

4. http://en.wikibooks.org/wiki/High_School_Mathematics_Extensions/Discrete_Probability

Elective 10: Natural Language Processing

Unit1: Introduction to natural language processing, word and sentence tokenization, text classification and sentiment analysis (1 credit)

Unit2: Spelling correction, information extraction, parsing, meaning extraction, and question answering (1 credit)

Unit2: Probabilistic models for NLP, machine learning (1 credit)

Unit3: Fundamental algorithms like n-gram language modeling, naive Bayes and Maxent classifiers (1 credit)

Unit4: Sequence models like Hidden Markov Models, probabilistic dependency and constituent parsing, and vector-space models of meaning (1 credit)

Unit5: PaNinian Grammar, Nyaaya and Mimansa theories (1 credit)

Unit 6: Case Study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Recommended Texts:

1. Jurafsky and Martin, Speech and Language Processing 2nd Edition

2. Manning, Schütze and Raghavan, 2008.
3. Peter Norvig, How to Write a Spelling Corrector, 2007

4. ANaambhatta, Tarkasamgraha

5. Ujjwala Jha, A Primar of Navya Nyaaya Language and Methodology

6. Ujjwala Jha, Mimansa philosophy of language

7. Akshar Bharati, Vinit Chaitanya and Rajeev Sangal, NLP – A Paninian perspective

Elective 11: Probabilistic Graphical Models

Unit 1: Review of Probability theory, introduction to PGM frameworks and their applications

Unit 2: The Bayesian network and Markov network representation, extensions for reasoning over domains that change over time, and over domains with a variable number of entities (1 credit)

Unit 3: Reasoning and inference methods, exact inference (variable elimination, clique trees) and approximate inference (belief propagation message passing, Markov chain Monte Carlo methods) (1 credit)

Unit 4: Learning parameters and structure in PGMs (1 credit)

Unit 5: Using a PGM for decision making under uncertainty. (1 credit)

Unit 6: Case Study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Recommended Texts:

1. Daphne Koller, Nir Friedman, Probabilistic Graphical Models: Principles and Techniques (Adaptive Computation and Machine Learning series)

Elective 12: Programming for robotics

Unit 1: Basics of AI, probabilistic inference, linear algebra (1 credit)

Unit 2: Computer vision, machine learning and robotics action planning (1 credit)

Unit 3: Localization of an object with particle filters, tracking moving objects with Kalman filters (1 credit)

Unit 4: Capturing objects in sensor data, path finding and optimal routing (1 credit)

Unit 5: Design and implementation of speed and direction controls (1 credit)

Unit 6: Case Study (preferably related to the research problem that has been undertaken by the candidate) (1 credit)

Recommended Texts:

Lecture notes at http://www.udacity.com/

Curriculum for Ph.D course work in Biophysics

The course work for Ph. D. will have total 18 credits of minimum six months to 18 months duration.

5. Each student after having been admitted to the Ph. D. degree programme, shall be required to undertake course work for a minimum period of one semester. The course work shall be treated as per-Ph. D. preparation.
6. The Ph. D. course work shall be offered with credit system. The entire course work will have total 18 credits. The student will have to earn 18 credits in maximum of three semesters.

Paper	Title	Max. credits
Paper I (BPHD101)	Research Methodology and computer applications	6
Paper II (BPHD102)	Biomathematics & Biostatistics	6
Paper III (BPHD103)	Based on core subject*	6

7. Course work will be handled by Research committee formed by the Research Centre.
8. Mode of study and evaluation for courses:

i) The continuous assessment of all the theory courses of Ph. D course work shall be done by the concerned Research Centre.. The internal assessment will have 40% weightage and external assessment will have 60% weightage. It may include assignments/class tests/case studies or seminar

ii) The external assessment shall be by assigning the topic to learner for the seminar, wherein the learner's contribution in collecting reference material, understanding the topic of the seminar work will have 30% weightage, presentation of the seminar and ability to answer the questions will have 50% weightage and punctuality, enthusiasm and aptitude of the student in preparing the seminar, writing the report will have 20% weightage. This will be evaluated by the Research Centre.

BIO-PHYSICS

Paper I: BPHD101

Course1: Research Methodology, Soft skills and computer applications

Paper I: Research Methodology and Computational Applications (80 hrs) 6 Credits

Section I: Research Methodology & Soft Skills:

Unit I Perception & comprehensive skill: Students perception skill will be evaluated using Seminar delivered by Scientists/professors/ Industrialist (R & D). Necessary seminars will be arranged by the department from internationally reputed Institutes/ University/Industries. Comprehensive skill will be evaluated based on open book tests.

Unit II Presentation / communication skill: Students skill will be evaluated by data collection and presentation from books/Journals. They will refer periodicals/ scientific databases (ex. Pubmed/ Protein / Genomics databases etc) or books. Student will asked to present in front of faculty / research committee of department.

Unit II Development of research proposals: Research proposal and its elements, Formulation of research problem-criteria of sources and definition, Development of objectives and characteristics of objectives, Development of hypothesis and applications.

Section II: Computer applications:

Unit IV: Use of word processing, spreadsheet and database software. Plotting of graphs. Internet and its application**:** E-mail, WWW, Web browsing, acquiring technical skills, drawing inferences from data,

Unit V: Statistical analysis and fitting of data : Introduction to Statistics – Probability Theories - Conditional Probability, Poisson Distribution, Binomial Distribution and Properties of Normal Distributions, Estimates of Means and Proportions; Chi-Square Test, Association of Attributes - t-Test - Standard deviation - Co-efficient of variations. Co-relation and Regression Analysis.

Unit VI: Data Analysis: Mathematical and statistical analysis using software tools like MAT Lab, SPSS, PsiLAB or free ware tools.

Main References:

1. Thesis & Assignment Writing–J Anderson, B.H.Dursten & M.Poole, Wiley Eastern, 1977
2. A Hand Book of Methodology of Research – P. Rajammal and P. Devadoss, R. M. M. Vidya Press, 1976.
3. The Craft of Scientific Writing by Michael Alley, (Springer).
4. Research Methodology by R. Panneerselvam, PHI, New Delhi 2005

5. Practical Research Methods, by Dawson, Catherine, 2002, UBS Publishers' Distributors New Delhi.
6. Research Methodology- A step by step Guide for Beginners, (2nd ed.) Kumar Ranjit, 2005, Pearson Education.
7. How to write and Publish by Robert A. Day and Barbara Gastel, (Cambridge University Press).
8. Survival skills for Scientists by Federico Rosei and Tudor Johnson, (Imperial College Press).
9. How to Research by Loraine Blaxter, Christina Hughes and Malcum Tight, (Viva Books).
10. The Craft of Scientific Writing by Michael Alley, (Springer).
11. A Student's Guide to Methodology by Peter Clough and Cathy Nutbrown, (Sage Publications).
12. Probability and Statistics for Engineers and Scientists" by Sheldon Ross, (Elsevier Academic Press).
13. Research methodology techniques and methods by C L Kothari, New age International publishers.

Paper II: BPHD102

Paper II: **Biomathematics & Biostatistics**:

Unit I:**Biomathematics**

Limits of functions, derivatives of functions. Probability Calculation, Differential and integral calculus, Derivative and its physical significance, basic rules for differentiation (Without derivation) Maximum and Minimum their application in chemistry, Geometric meaning of integration, application in biology and chemistry.

Unit II:BIOSTATISTICS

1. Introduction, scope, application and use of statistics, collection and classification Of data, census and sampling, graphs and diagrams, arithmetic mean, median standard Deviation.

2.correlation and regression for ungrouped data, scatter diagram, calculation and Interpretation of correlation coefficient, linear regression coefficients and equation of the Lines of regression, nonlinear relationship transformable to liner form ($Y=Ab^x$, Ya^xb)

3. Probability, definition, addition and multiplicative laws (without proof). Random variable and its distribution, binominal probability distribution, examples and condition s means and Variances, continuous variable, normal distribution, use of normal probability table for finding probabilities.

4. Population parameter and sample statistics, sampling techniques, simple random Sampling stratified random sampling, systematic sampling standard error of mean.

5. Estimation, Point & interval, confidence interval for proportion.

6.Hypothesis attesting, Type I and Type II errors levels of significance, one-tailed and two tailed test, application to single proportion, equality of the population

Means and two population proportions.

7. Chi-square test for independent attributes in r x c table, special case of 2 x 2 tables.

8. Students test for significance of correlation coefficient y fore p=0 (small sample test)

Fishers z transformation coefficient for getting yp-0 in large samples test of significance

For y (p=0)

9.Design of experiment: Principle and concepts of completely randomized design, randomized block design and Latin square design,

10.variance ratio F-test-Analysis of variance in one-way classification .

11.Non-parametric test: Distribution-free method, sign test for method pairs, Wilcoxon test for unpaired data Run test.

References:

1. Biostastistics:A foundation for analysis in the Health Sciences, 7th Ed.(1998) Wayne D, Wiley
2. DNA Microarrays, David Bowtell & J Sambrook (2002), CSHL Press
3. Principles of Statistics, 2nd Ed. M Pagano & K Gauvreau (2007), Thomson Publ

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Paper III: BPHD 103

One module to be completed out of the following:-

Module 1: Basics Principles in Biophysics
Module 2: Cell Biophysics
Module 3: Biophysical Methods
Module 4: Molecular Biophysics
Module 5: Biochemistry
Module 6: Radiation & Medical Biophysics
Module 7: Bioinformatics
Module 8: Nanobiology/ Nanotechnology

Details of Module:

Module 1: Basics Principles in Biophysics

Structure & Bonding: Quantum mechanics: Pauli Exclusion Principle, Ionization energy, electron affinity and chemical binding, Electronegativity and strong bonds, secondary bonds. The electronics structure of atoms, Molecular orbital and Covalent bonds. Molecular interaction: strong and weak interactions. Stereochemistry and Chirality,

Thermodynamics: Basics of Thermodynamics: Laws of thermodynamics and living organisms, Entropy, Enthalpy, Efficiency and free energy of system, Concept o energy in biological system, living body and thermodynamics, Carnot cycle, Chemical potential.

Kinetics of Molecules & Reactions: 0^{th}, 1^{st},2^{nd} & 3^{rd} order reactions, Diffusion, Osmosis, Osmotic pressure, osmoregulation, surface tension, dialysis, adsorption, viscosity, thermal conduction, collides, sedimentation**.**

Acid-Base equilibrium: Bronsted lowry theory, protonationa and deprotonation, buffers, amphiprotic system, protolysis of water, hydrogen ion concentration, pH, acid base balance, Henderson and Hasselbalch equation.

References:

1. Physical Chemistry for Life Sciences,Peter Atkins and Julio de Paula, 2006, Oxford Press
2. Introduction to Biophysics by Cortell
3. Molecular and Cellular Biophysics, Meyer B Jackson (2006), Cambridge)
4. Tex Book of Biophysics , R N Roy, New Central Agency (P) Ltd, Culcutta
5. Physical Chemistry for the Biosciences, Raymond Chang,(2004), University book Science Biological Thermodyanamics, Donald, T Hayine, (2007), Cambridge

Module 2: Cell Biophysics

General organization of cells: General organization of prokaryotic and eukaryotic organisms and their structure functions.

Cell Differentiation: Cellular differentiation; localization of cytoplasm determinants in egg. Nucleocytoplasmic interaction and cell function, Development of extra cellular matrix, mechanism of alpha adrenergic and related response, modulation of extra cellular matrix by tumor cell- Fibroblast interactions, growth factors in cultured cell-early cytoplasm singles and Cytoskeleton responses.

Cell growth and Division: Kinetics of cell growth, Role of protein kinase in cell growth, cell cycle, cell cycle events: G S G2, Cell division, cytokines, control of cell cycle, Role of protein kinase c in cell growth, dividing and non-dividing cell, synchronization of cell growth, cell transformation, malignant tumor growth, Apoptosis.

Cell-Cell Communication: Strategies of chemical signaling: Endocrine, paracrine and synaptic. Signaling mediated by intracellular receptors: Mechanisms of transduction by cell surface receptor protein, role of calmodulin, Ca and cyclic nucleotides, phosphoinisitol cycle, sodium proton exchanger, molecular events involved in during sperm-egg interaction, implications and the mechanisms of sperm-zone interaction, Role of soluble factors produced by follicle somatic cell on gamete interactions. Factors influencing sperm egg recognition and binding.

References:

1. Molecular Biology of the Cell, Bruce Albert, Alexander Jhonson et al (2002), Taylor & Francis Group.
2. The Cell Molecular Approach, G Cooper & R Hausman (2007) ASM Press
3. Molecular Biology , D Roberties, 8th Ed. SAE
4. Biochemistry by Strayer
5. Introduction to Biological Membrane, D Chapman
6. Molecular Cell Biology, Lodish
7. Molecular and Cellular Biophysics, Meyer B Jackson (2006), Cambridge)

Module 3: Biophysical Methods

Spectroscopy: Principle, instruments and application of spectroscopic instruments: UV Visible: absorption of light, radiation sources, sample holders, monochroamtors, radiation detectors, single and double beam instruments, Colorimeter. IR spectroscopy: Rotational and vibration spectra, Instrumental features, applications. Raman: Raman effect, stokes and anti-stokes lines, advantages, applications. CD ORD principles and applications. Fluorescence: Fluoresces and phosphorescence phenomenon, quenching, energy transfer, and applications. Atomic absorption spectroscopy: Principle and instrumentations.

Microscopy: Principle, instrumentation and application of Microscopy, image formation, magnification, resolving power. Different types of Micrscopy: Dark field ,Phase contrast, polarization microscopy, Fluorescence, Electron microscopy: Electron guns, Electron lens,

Separation techniques Electrokinetics methods: electrophoresis, electrophoretic mobility (EPM), factors affecting EPM, Paper, PAGE, Capillary, Iso-Electric focusing, applications in biology and medicine. HPLC: mobile phase systems, modes of operations, application, Hydrodynamics method:

fundamental principles, Centrifugation, Ultracentrifugation and their applications in molecular weight, size determination. Viscosity and its application.

References

1. Methods in Molecular Biophysics, Igor N S, N Zaccai & J Zaccai, (2007) Cambridge
2. Principle of Biochemistry, D Voet, J Voet and CW Pratt, 3rd Ed,
3. DNA Clonning, Grover Vol. I, II, III
4. Advanced Methods in Protein Microsequencing, Witmann
5. Essential Biophysics, Narayanan, New Age Publ
6. Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley

Module 4: Molecular Biophysics

Principles of proteins structure and confirmations: Basics problems of protein structure, Polypeptide chain geometrics, estimates of potential energy, results of potential energy calculations, hydrogen bonding, hydrobhobic interactions and water as universal solvent in biological systems, Disruption of hydrophobic interactions by urea, ionic interactions, hydrophobic versus ionic interactions, Disulfide bond, Ways of pairing N-half cystine, formation of specific disulfide link, prediction of protein structure.

Protein structure & stability: Two state model of protein stability, chemical denaturation and stabilization, surface denaturation. Principles of ionization equilibrium ionization of side chain, equilibria in proteins. Predicting properties from amino acid composition, Usual amino acids. Primary structure sequencing of polypeptide, hemoglobin, homologies in proteins, Secondary structure alpha and beta confirmation, collagen structure, stability of alpha helix, Ramchandran plot, Tertiary structure, structure of myoglobin and hemoglobin, Quaternary structure, symmetry consideration, Analysis of subunits and chain arrangement of subunits, stability of globular quaternary structure. Protein folding rules, pathways and kintetics.

Structure of Nucleic Acids: Ionization equilibria of nuclosideand nucleotides: compositions of nucleic acid, Chargaff's rule in DNA, RNA base compositions, Primary structure, Covalent chain structure, secondary structure inferences from RNA sequence comparisons, sequence information and analysis of structure function. Structure DNA & RNA

Molecular distribution and statistical thermodynamics: Binding small molecule by polymer, identical and independent site model, nearest interaction and statistical weight, cooperative binding, anticoperative binding and excluded site binding. The random walk, Helix coil transition in protein.

References:

1. Biophysical Chemistry, The Behaviour of biological macromolecules, Vol I,II, III, Cantor and Schimmel, (2008), W H Freeman & Co
2. Applied Biophysics, A Molecualr Approach for Physical Scientist, Tom A Weigh, (2007), Wiley
3. Introduction to Protein Sciences, Arthur M Lesk (2004), Oxford Press
4. Molecular and Cellular Biophysics, Meyer B Jackson (2006), Cambridge)
5. Chemical Biophysics, Daniel A Beard and Hong Q (2008), Cambridge Univ Press
6. Proteins Structure & Function, David Whitford (2005), Wiley
7. Introduction to Protein Structure, Carl Brenden & Jhon Tooze (1999), Garland Publ, NY

8. Essentials of Biophysics, P Narayanan (2005), New Age Publ.
9. Physical Chemistry for Biomedical Sciences, S R Logan, (1998), Taylor & Francis.
10. Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley
11. Principal of Protein Structure, GE Schulz, RH Schirmer (2004), Springer

Module 5: Biochemistry

***Hormones action*:** cAMP/cGMP, G protein and G protein family receptor, G protein cascades, c-AMP and protein kinase, protein phosporylation, Inositol triphosphate and DAG signals.

***Replication and Repair*:** A B & Z DNA structure, major & minor groves in DNA, Protein DNA interactions, supercoiling of DNA, Topoisomerase I and relaxed DNA, DNA gyrase, eukaryotic gene. Replication in vivo, semi-conservative mechanism of replication. Direction of replication. Discovery of DNA polymerase I and its function. DNA synthesis in vitro, other DNA polymerase, role of various proteins/enzymes in DNA synthesis. Model of DNA synthesis, molecular basis of mutations, DNA repair mechanism, reverse transcription.

Transcription & *Translation*: RNA polymerase and its action, promoter sites of DNA template, sigma factor, elongation and termination of RNA chain, processing of precursors-RNA,sn-RNA and tRNA, mRNA. RNA polymerase I and transcription of mRNA in eukaryotic cells. Transcription factors in eukaryotes. Ribozyme and self splicing, genetic code-discovery and silent features.

Recent advances, amino acid activation, fidelity of aminoacyl, tRNA synthesis, tyrosyl AMP complex, tRNA structure and function. Ribosomal RNA structure, Architecture of EM and neutron diffraction. Initiation of protein synthesis, translocation and peptide bond formation, termination and stop codon, protein synthesis in eukaryotes.

Regulation of Gene expression in prokaryotes & Eukaryotes: Operator-operon concept, Negative and positive control of transcription with example of lac operon and Arbinose operon. Control of transcription, control of regulatory protein, transcription termination, repressor, cro protein.

Eukaryotic RNA, role of histone, nuclosome, bidirectional replication, repetitive DNA, transcriptiona; factor IIIA.

Ligand receptors interaction: Kinetics model based on steady state assumptions, allosteric interactions and co-operative behavior regulation and control system in biology

Reference:

Molecular cloning by Maniatis Vol. I, II, III

DNA cloning by Glover vol. I, II, III

Genome analysis a practical approach by devis.

Protein engineering practical approach by Reas.

Advanced method in protein micro sequence by Witmannn.

Principles of Biochemistry, Leninger (2008(, Freeman Publ

Module 6: Radiation Biophysics & Medical Biophysics

Element of Nuclear Physics: Structure of atom. Nuclear Nomenclature. Nuclides Chart Radioactivity. Alpha Beta and Gamma Radiation. Radioactivity series. Decay low Half-life, Nuclear Reactions.

Interaction of Radiation with Matter: Ionization and Execution of matter by charged Particles, Specific ionization, Linier Energy Transfer (LET), Bragg curve, Range Energy Relations, Bremasstrahlung, Interaction of Gamma rays with Matter, Photoelectric effect, Compton effect pair production, Attention and absorption coefficients

Interaction Of Radiation with living cells: Direct and indirect effects of radiation. Target Theory modification of cell survival by oxygen. Dose rate and dose fractionation. Repair And recovery. Factors affecting radiation dose. Nature of DNA damage induced by Radiation. Basis of radio sensitivity of cells. Chromosome aberrations and mutations law of Bergonic and Tribondeau.

Biological effects of Radiation: Introduction historical data base genetic, somatic, Immediate and later effects. Stochastic and nonstoichasic effects. Damage to individual Organs. Skin, lung, eye, leans, reproductive system endocrine glands, threshold doses, Radiation sickness, Radiation syndromes: haemopoietic Syndrome G.I. Syndrome, CNS Syndrome LD50 (30) dose, Late damage in skin, lung and other organs. Maximum Permissible limits for radiation exposure. Late stoichastic effects. Radiation Carcinogenetic risk

Whole body count: Principal of whole body counting, design of whole counting System, stationary and moving systems, calibration of whole body counter, medical Application in absorption and turnover studies, medical radioprotection in children, Detection of stable nuclides.

Absorption Studies using labeled Compounds: General principals of absorption studies Using labeled compounds general technique of absorption of labeled compounds. Absorption of vitamin B_{12} with ^{38}Co and ^{59}Co, Fe absorption and turnover studies, Plasma Iron clearance, Detection of Red cell iron and assessment of Disorders of haemolysis, Absorption and turnover studies of albumin and other nutrients. Breath testing with carbon 14 labeled compounds.

Reference:

1. Fundamental and Radiobiology (1966) 2nd Edition Bacu Z.H. Alexander P., Pergammon Press, New York.
2. Radiation Biophysics (1990) Alpen E.L.Printice hall, Engel Wood.
3.Radiation Chemistry (1973) Hughes G. Clarendon Press,

4. Polymers as Biomaterials Ed. By Shalaby W., Shalaby W. Plaenum press, N, Y.(1984)
5. Introduction physics of nuclear medicine by Chandra, R.
6. Nuclear Medicine by Lelle, R.D.
7. Technology and interpretation of nuclear medicine procedures by Sodee. D.B. and Early, R.J
8. Nuclear Medicine by Wagnar, H.N.
9. Medical physic by Cameron J.R

MEDICAL BIOPHYSICS.

Operational Characteristics of Scanners: Quantitative parameters for measuring factors Affecting spatial resolution and sensitivity of a scanner and scintillation camera, uniformly and high count rate performance of a scintillation camera.

Tomographic studies and instrument: Principal and met5hodology of longitudinal Tomography, computerizes axial tomography, single photon emission computerized Tomography, positron scanning, florescent detection and scanning, magnetic resonance imaging, Electrical impedance tomography.

Radio dynamics: Principal of dynamic studies in radiation medicine. Renogram, Nucleo-Venography, radiocardiography liver cold area blood flow, Radio-aerosol lung ventilation And perfusion imaging, Functional assessment of polygonal, cell, cerebral blood flow astric emptying time.

Whole Body counting: Principal of whole body counting, design of whole body counting, System, stationary and moving systems, calibration of whole body counter, medical Application in absorption and turnover studies, medical radioprotection in children, Detection of stable nuclides.

Absorption Studies using labeled Compounds: General principals of absorption studies Using labeled compounds general technique of absorption of labeled compounds. Absorption of vitamin B_{12} with ^{38}Co and ^{59}Co, Fe absorption and turnover studies, Plasma Iron clearance, Detection of Red cell iron and assessment of Disorders of haemolysis, Absorption and turnover studies of albumin and other nutrients. Breath testing with carbon 14 labeled compounds.

Imaging of the body organs: Static liver image, entopic gastric mucosa, gastrointestinal Bleeding pancreas, thyroid, gonads, static brain images and space occupying lesions, ling Scan in pulmonary emboli and ventilation studied, myocardial perfusion, infarct imaging And thrombosis detection, whole body imaging of skeletal systems, urinogenital systems, White cell and tumor imaging.

Quality Control in Radiation Medicine: (a) Radio pharmaceuticals: Quantity control in Molybdenum 99/Technitium-99m generators and Sn-113/in-113m generator.

Breakthrough of Chemical/stable molybdenum, stannous, 99Mo and 113Sn. Controls of Alumina, MEK and Zirconium breakthrough. Assessment of radiochemical purity of Radiopharmacutical, Particle sizing, Stabling and Pyrogen testing

Scanner: Calibration of camera, Uniformity turning of Camera, Content of spatial Distribution and resolution.

Dose Calibrator: Accuracy, Consistency, linearity geometric calibration. Calibration of Nonimaging scintillation detector and multicrystal well conters.

Diathermy: Introduction, thermal response of tissues, coupling of tissues, short wave and Microwave diathermy.

Reference:

1. Fundamental and Radiobiology (1966) 2nd Edition Bacu Z.H.
Alexander P., Pergammon Press, New York.
2. Radiation Biophysics (1990) Alpen E.L.Printice hall, Engel Wood.
3.Radiation Chemistry (1973) Hughes G. Clarendon Press,
4. Polymers as Biomaterials Ed. By Shalaby W., Shalaby W. Plaenum press, N, Y.(1984)
5. Introduction physics of nuclear medicine by Chandra, R.
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8. Nuclear Medicine by Wagnar, H.N.
9. Medical physic by Cameron J.R.

Module 7: Proteomics , Genomics, Molecular Modeling & Bioinformatics

Genomic: Genetic mapping, linkage analysis and genotyping, restriction mapping DNA fingerprinting DNA markers including RFLP, Micro/mini satellites, SNPs, RAPDs, Etc. Comparative genome molecule taxonomy. Proteomics: Different methods used for Protein analysis, identification of protein by different biochemical and biophysical Techniques.

Molecular Modeling: Molecular geometry and energy; Molecular mechanics (MM) Potential functions MM force fields; Energy minimization techniques; normal mode Analysis; free energy calculation; molecular dynamics; Dynamics of proteins, nucleic Acids. and their solvent surrounding; Monte Carlo simulations; Computer graphics.

Bioinformatics:

I Introduction to bimolecules and central dogma of molecular biology

II Organization of biological data, database (raw and processed) quering in

III Primes in Biology

IV Combinatorial problem in biology
V Gene finding motif finding and multiple sequence alignment
VI Mechanism and flow of information in Biology
VII Protein sequence analysis (Theory and algorithms)
VIII Protein structure analysis and application
IX Relation data Base concept in Biology
X Microarry Technology and Basics.
XI Microarry analysis of Biological Data
XII Management and analysis of Biological data
XIII A Perspective on Human genotypes, Modeling of network
XV Proteomics
XVI Modeling regulation of genetic network
XVII Exploration of database, retrieval of desired data, blast etc.
XVIII Gene clusters and fusions, consensus sequences, exon-intron finder sequence logo
XIX 3D structure data
XX Gene expression profiling and its applications
XXI Integrated approach of Bioinfomatics and molecular modeling for Drug design, Agriculture, medicine
XXII Bioinfomatics and Biodiversity.

Information Theory and application in Biology: Languages General discussion; Stochastic Processes: markav processes; ergede sequences; redundancy, information and sensory Perception, Information theory and protein structure; coding of genetic information

Referances:

Adras D. baxeanis 200. The Molecular biology database collection; an updated Complication of biological database resources. Nucleic Acid research 2001. 29: 1-10

Fasman K.H. and salzberg S.L. 1998. An Introduction to biological sequence analysis. In Salzberg S.I.et al(Ed). Computational methods in molecular Biology 29-63, Elsevier Science B.V.

Higgins D.G.et al 1996. Using cluster for multiple sequence alignment. In Doolittle R.F. (Eds). Methods in Enzymology 256:393-405 (Academic)

Litchtarge et al 1996.JMB 257: 342-358

Yona G. 2000. NAR 28: 49-55

Slawiski et al 2000. PNAS (USA) 97: 3954-3958

Xu ET AL 2000. Current protein and peptides science 1:1-21

Molecular cloning: 3rd edition. Sambrook and Russell (eds)
Gullman, S>R.2000. Of Micro array and meandering data points. Nat. Genet. 26:405
Endy and Brent 2001. Modeling cellular behaviors, Nature. 409: 391-395

Module 8: Nanobiology/ Nanotechnology

6. Fundamentals of nanomaterials and nonostructures
7. Synthesis of nanoparticles, nanoclusters, nanocrystals; top-up approach and bottom-up approach, Self-Assembly.
8. Properties of Metal Nanoclusters, Semiconducting Nanoparticles, Rare Gas and Molecular Clusters and Nanotubes.
9. Characterization of nanomaterials and nanostructures: structure, particle size, distribution.
10. Applications of nanotechnology in Biology and Medicine, Sensors, Coatings.
11. Techniques used in Nanosciences such as AFM, DLS, SEM etc : Principles and their application.

Name of the research centre

Certificate

This is to certify that Mr/Ms/Mrs…(Surname) ……(First name) ……(Second name)……. has been a regular student of Ph.D. with registration number …….. He/She attended the course work conducted at the recognized research centre/department from …… to …… during the year …… He/She has successfully completed the Ph.D. course work prescribed by the University of Mumbai. He/She secured ……. grade in seven point scale.

Date: Guiding teacher Head of the Department/principal

Seal Name: Name: