SYLLABUS OF COURSE WORK FOR PH. D PROGRAMME

Interdisciplinary Research in Science

Panskura Banamali College Research Center
Affiliated to Vidyasagar University

Panskura Banamali College (Autonomous)

Panskura R S: Purba Medinipur
West Bengal- 721152

Syllabus for the course work of Ph.D. programme

Panskura Banamali College Research Center

(Interdisciplinary Research in Science)

Affiliated to Vidyasagar University

- **Duration of the course work: One Semester (6 months)**
- **Total paper – 4 (Four): Total Credit – 16**
- **Total Marks – 200 (Four papers 50 marks each)**
- **Duration of Examination – Two hours each paper**

Syllabus structure of course work for Ph. D programme

Course	Paper	Subject	Credit	Full Marks	Total Lecture
Compulsory	**I**	**Research Methodology**	**4**	**50**	**40**
	II	**A. Basics of Computer Application and Statistical Method** **B. Language Skill Development for Scientific Paper Writing and Editing**	**4**	**50**	**40**
Elective ***(Anyone to be chosen by the student)***	**III**	**1.Methodologies in Chemistry** **2. Methodologies in Mathematics** **3. Methodologies in Zoology** **4. Methodologies in Computer Science** **5. Methodologies in Geography** **6. Methodologies in Economics** **7. Methodologies in Physiology** **8. Methodologies in Physical Education**	**4**	**50**	**40**
Review and Project work	**IV**	**A. Review work** **B. Project work** ***(Each student must submitted the report duly signed by the Project Supervisor assigned by the Research Center)***	**4**	**50**	**40**

Syllabus for the course work of Ph.D. programme
Panskura Banamali College Research Center

Paper-I
Research Methodology
(Each unit 5 lectures)
50 marks

i. **Scientific Process:** Meaning and definition, a brief history of scientific process

ii. **Introductions to research methodology:** Concept and definition of research, objectives of research, types of research, significance of research, stages of research.

iii. **Research problems:** Definition, necessity and techniques of defining research problem, formulation, objectives and justifying research problem.

iv. **Research design**: Meaning need and features of good research design, types of research designs; Experimental designs: basic principles, types and validity.

v. **Sampling designs:** Census and sample surveys, Sampling types, designs and determination of sample size. Probability distribution, sampling distribution of sample mean and variance.

vi. **Editing, Data collection and Validation:** Primary and secondary data, methods of collecting primary and secondary data, importance and methods of editing and data validation. Methods for developing a structured questionnaire and guideline for questionnaire survey. Experimental based data generation.

vii. **Hypothesis:** Definition, testing of hypothesis, procedures of hypothesis testing, flow diagram for hypothesis testing, parametric and non-parametric tests for testing of hypothesis, limitations of hypothesis.

viii. **Paper / Thesis Writing and Report generations:** Basic concepts of paper their writing and report generation, review of literature, concepts of Bibliography and References, significance of report writing, steps of report writing, types of research report, methods of representation of report. Code of ethics, permission to research, responsibilities, confidentiality, concept of plagiarism.

ix. **Instrumentation:** Description and principles of (a) Electrophoresis, (b) PCR Machine, (c) Laminar flow (d) Ultracentrifuge (e) Autoclave, (f) Light and electron microscopy. Handling of instruments and precautions.

x. **Safety Measures:**

1. ***Laboratory Safety:*** Introduction, Code of conduct – while entering in the laboratory, while working with chemicals, disposal of chemicals; Storage and disposal of chemical waste, organic and radioactive wastes. Human contribution to reduce hazardous wastes.
2. ***Field safety:*** Security during field trip / expedition, self-care, cares from wild animals, hazard warnings. Precautions during visit to library and other offices. First aid in the fields**.**

Paper II

Computer Application, Statistical Methods and Skill Development

(50 marks)

A. Basics of Computer Application and Statistical Method (30 Lectures)

Fundamentals of computers: Number system - binary, octal and hexadecimal, base conversion. Numbers: Integers, functional numbers of presentation, power, large numbers, small numbers, round off, approximation.

Operating system - Definition, types of OS. Use of software – Linux, Windows: MS Office - Power Point, Word, Excel and Access, LATEX/WINEDT. Software Packages: MATLAB, MATPLOTLIB, SPSS and R.

Internet: Data uploading and downloading, INFLIBNET, Sodhganga. E-journal.

Field and Computer hazards: Misuse of internet, hacking, Field hazards

Fundamentals of Statistics

a) Probability Distribution Samples and Population, Statistics and Parameters, Random Sampling, Measurement of Central Tendencies, Measures of Variations.

b) Correlation Coefficient: Simpler linear, multiple linear and partial regression

c) Probability distributions: Normal, Binomial and Poisson.

d) Statistical Inference, Testing Hypothesis: Student ‘t’ test, ‘f’test, Chi Square tests. Correlation, Regression, Time series and Panel data analysis, Basic operation of Matrix and Determinants, ANOVA

B. Language Skill Development for Scientific Paper Writing and Editing (10 Lectures)

Basic grammar, Functional grammar through usage and practice,

Passage reading and understanding

Dictation for flawless writing and new vocabulary based activity

Phonology, Word tree-word cycle, Report writing-editing, Paragraph-Summary, gist, note making, Mouth exercise, Telephone Conversation, Computer Typing

Suggested readings (for Paper – I & II)

1 Rogerson P A. (2018) Statistical Methods for Geography: A Student's Guide (Fifth Edition), SAGE publishing.

2 Brunsdon C, Comber. L, (2018) An Introduction to R for Spatial Analysis and Mapping (Second Edition), SAGE publishing.

3 Guthier, G (2010), Basic Research Methods, An Entry to Social Science Research, SAGE publishing.

4 Burkholder G J, Cox K A, Crawford L M, Hitchcock J H, (2014), Research Design and Methods: An Applied Guide for the Scholar-Practitioner, SAGE publishing.

5 Kothari C. R., (2004). Research Methodology: Methods and Techniques, New Age International Pvt Ltd Publishers.

6 Chawla D and Sondhi N, Research Methodology Concepts and Cases, Vikas Publishing House Pvt. Ltd.-Noida, 2011.

7 Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics, The World Press Private Limited.

8 Wilkinson and Bhandarkar, Methodology and Techniques of Social Research, Himalaya Publishing House.

9 Silberschatz G, Operating System Concepts, Wiley Publishers.

10 Tickell A, Sheppard E, Peck J and Barnes T (2007), Politics and Practice in Economic Geography, SAGE publishing.

11 Fuscaldo, AA, Erlick, BI, Hindman, B. Laboratory Safety: Theory and Practice. New York: Academic Press, 1980.

12 Blum, Deborah and Mary Knudson, eds. A field guide for science writers: the official guide of the National Association of Science Writers, New York: Oxford University Press, 1997.

13 Booth, Wayne, Gregory G Colomb, Joseph M. Williams. The craft of Research Chicago University of Chicago Press, 1995.

Paper – III

Elective Paper

Each paper 50 marks (4 credits)

1. Ph.D. Course work syllabus for Chemistry (40 Lectures)

1. Introduction to materials characterization: (a) Types of materials (b) Physical and chemical properties of materials (c) Necessity of characterization. (2)
2. Techniques for separation of mixtures: TLC, PLC, GC, HPLC (3)
3. Characterization of organic molecules using spectroscopy: UV, IR, NMR, HRMS (10)
4. Characterization of materials and nano structure: XRD, TEM, HRTEM. (5)
5. Surface structure and topography: SEM, STM, AFM (5)
6. Phase changes, crystalline and amorphous fractions-(DSC) (5)
7. Thermo-gravimetric methods: TGA, DTA (5)
8. Mechanical properties: Elastic properties, strength measurements in bulk and thin films, nano-identification. (5)

Suggested Reading:

1. Tanmoy Chakraborty, Lalita Ledwani, (2016) Research Methodology in Chemical Sciences: Experimental and Theoretical Approach, Apple Academic Press.
2. Nekane Guarrotxena (Editor) (2014), Research Methodology in Physics and Chemistry of Surfaces and Interfaces, Apple Academic Press.
3. Michael Smith, (2016), Organic Synthesis, 4th Edition, Academic Press
4. Kenneth Schmitz. (2016), Physical Chemistry: Concepts and Theory, 1st Edition, Elsevier.
5. Paul Worsfold Alan Townshend Colin Poole Manuel Miró, (2019), Encyclopedia of Analytical Science, Elsevier.
6. James House Kathleen House, (2015), Descriptive Inorganic Chemistry, Academic Press.
7. Gregory S. Patience, (2013), Experimental Methods and Instrumentation for Chemical Engineers, Elsevier.
8. Francis Rouessac, Annick Rouessac, (2008), Chemical Analysis: Modern Instrumentation Methods and Techniques, 2nd Edition, ACS Publications.

2. Ph.D. Course work syllabus for Mathematics (40 Lectures)

Operations Research, Optimization, Fuzzy Set , Intuitionistic Fuzzy Set, Neutrosophic Set, Soft Set, Graph Theory (40 Lectures)

A. Operations Research and Optimization (20 lectures):

a) Production planning for unreliable production systems. Integrated production, Production planning and inventory control models. Stochastic problems.

b) Supply chain – definition, decision phases, process view. Centralized supply network versus decentralized operation. Multi-echelon supply chains. Simple models of supply chain management.

c) Game theory: Mixed strategy game problem and its solution procedure.

d) Prey – Predator Model

e) Optimization Method: Linear Programming Methods like Simplex method, Big M method, Dual Simplex method, Transportation problem and its solution method, Assignment problem and its solution method. Non-linear programming methods like non-linear optimization without constraints and with constraints, Lagrange multiplier method, Geometric programming method, Stochastic programming method, Multi-objective optimization methods, Soft Computing methods – Genetic Algorithm, Artificial Neural Network, Particle Swam Optimization, etc.

B. Fuzzy Set, Intuitionistic Fuzzy Set, Neutrosophic Set, Soft Set (15 lectures)

Definition of Fuzzy set, various types of fuzzy sets, normality, convexity; Arithmetic Operation on fuzzy sets, Triangular norm (t-norm), t- conorm, Defuzzification Methods: Graded Mean, Centre of gravity, Signed Distance , α- cuts, Euclidean distance method, Higher dimensional fuzzy set, Metric Space Geometry and fuzzy metric spaces. Intuitionistic Fuzzy Set (IFS) – Algebraic structure of IFS, Neutrosophic Set (NS) – Introduction and basic properties. Soft Set- Introduction and basic properties.

C. **Graph Theory:** Basic properties and applications, Concept of Fuzzy graph**. (5 Lectures)**

Suggested Reading:

1. Operations Research by H.A.Taha
2. Operations Techniques by Chander Mohan and Kusum Deep
3. Engineering optimization by S.S.Rao
4. Fuzzy sets and fuzzy logic by Klir and Bo Yuan
5. Fuzzy sets, Uncertainty and information by Klir and Folger
6. Fuzzy sets and logics by H. J. Zimmerman
7. Graph Theory with Applications, J.A. Bondy and U.S.R. Murty, Elsevier North- Holland
8. Graph Theory and Its Applications. J.L. Gross and J. Yellen, CRC Press
9. Graphical Enumeration, F. Harary and E. Palmer, Academic Pres
10. Graph Theory With Applications To Engineering And Computer Science, NarsinghDeo, Phi Learning
11. Graph Theory, F. Harary, Narosa Publishing House
12. Gabriele Eichfelder, Adaptive Scalarization Methods in Multiobjective Optimization, Springer Verlag, 2008.
13. Johannes Jahn, Vector Optimization Theory, Applications and Extensions, Springer Verlag, 2011.
14. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley &Sons, Chichester, 2001.
15. Goldberg, D. E. (1989). Genetic algorithms in search, optimization, and machine learning. Reading, MA: Addison-Wesley.

3. Ph.D. Course work syllabus for Zoology (40 Lectures)

UNIT-1- Cytology and Histological Techniques (10)

a) Elements of microtomy- pre-microtomy processes, microtomy process, post microtomy process.

b) In situ and histological staining techniques- Whole mount (In situ) staining techniques, microbial staining techniques.

c) Histochemistry- General histochemistry, enzyme histochemistry, immunochemistry.

d) Microscopy- Light microscopy, electron microscopy, Confocal and other advanced microscopy, Image capture & Processing

UNIT- 2– Ecology & Biodiversity Analysis (10)

a) Analysis of Population Characteristics.

b) Biodiversity: Concept & definition, scope and constraints of biodiversity science. Factors promoting high diversity, global biodiversity. Mega biodiversity centers, hot spots.

c) Measures of Biodiversity-Diversity indices, Measuring ecosystem diversity.

UNIT-3- Bioinformatics & Phylogenetic Analysis (10)

a) Applications of computer in Taxonomy and biodiversity study

b) Use of computer in biostatistics

c) Collection, preservation and maintenance of animals for biodiversity studies.

d) Genomics &Proteomics- genomics, genome wide analysis of gene structure and expression. Proteomic analysis by mass spectrometry and Construction and analysis of Phylogenetic trees.

UNIT -4 - Physiological and Biochemical Techniques (10)

a) Biochemical methods- Centrifugation, spectroscopy, chromatography, electrophoresis.

b) Detection and assay of enzymes- Chemistry and classification, qualitative and quantitative detection. Time Kinetics.

Suggested Reading:

1. Thompson S.W. (1966) – Selected Histochemical and Histopathological Methods. Pub. C.C.T.I., USA.
2. Gabe M. (1976) – Histochemical techniques. Pub. Springer Verlag, New York.
3. De Robertis *et al.* - Cell Biology. Pub. W.B.S.C.P., London.
4. Stoward P.J. – Fixation in Histochemistry. Pub. Chapman and Hill, London.
5. Roe, Crabtree and Kahn – DNA Isolation and Sequencing. Wiley.

4. Ph.D. Course work syllabus for Computer Science (40 Lectures)

1: Digital Logic: Boolean algebra. Combinational and sequential circuits. Minimization. Number representations and computer arithmetic (fixed and floating point). (5)
2: Computer Organization and Architecture: Machine instructions and addressing modes. ALU, data-path and control unit. Instruction pipelining. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode). **(5)**
3: Programming and Data Structures Programming in C: Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs. **(5)**
4: Algorithms: Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide-and-conquer. Graph search, minimum spanning trees, shortest paths. **(5)**
5: Compiler Design: Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation. **(5)**
6: Operating System: Processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU scheduling. Memory management and virtual memory. File systems. **(5)**
7: Databases: ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control. **(5)**
8: Computer Networks Concept of layering. LAN technologies (Ethernet). Flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state). TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP, HTTP). Basics of Wi-Fi. Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls. **(5)**

Suggested Reading:

1. Introduction to Algorithms by Rivest, Cormen, Stein, Leiserson, MIT Press
2. Operating System Concepts by Galvin, Silberschatz.WILEY Publishers
3. Introduction to Automata Theory, Languages and Computation by Hopcroft, Ullman. Pearson Education
4. Computer Networking: A top-down approach by Kurose-Ross. Pearson Education
5. Computer Networks by Tanenbaum, Prentice Hall
6. Computer Organisation by Carl Hamacher. McGraw Hill
7. Computer Systems: A Programmer’s Perspective, Randal E. Prentice Hall
8. Java: The Complete Reference, 8th Edition, Herbert Schildt. McGraw Hill
9. Database System Concepts by Korth. McGraw Hill
10. Principles of Compiler Design by Aho and Ullman. Narosa Publishing House
11. Digital Logic and Design by Morris Mano. Pearson Education, Prentice Hall
12. Software Engineering: A Practitioner's Approach by Pressman. Prentice Hall

5. Ph.D. Course work syllabus for Geography (40 Lectures)

1. Man and Environment: Man-nature relationship, environmental hazard and mitigation strategies. **(5)**

2. Climate and development: Climate change at global and local scale, climate and sustainable development. **(5)**

3. Regional development: Agriculture and industry, causes of imbalances, process and methods of development. **(5)**

4. Social development: Indicators and techniques of development for health and education. **(5)**

5. Gender and development: Regional dimension analysis with special reference to India. **(5)**

6. Human development: Importance, indicators, method of calculation. **(5)**

7. Urban analysis: Methods of urban analysis. **(5)**

8. Geospatial techniques: Applications of RS & GIS in Geoscience research. **(5)**

Suggested Reading:

1 Rogerson P A. (2018) Statistical Methods for Geography: A Student's Guide (Fifth Edition), SAGE publishing.

2 Brunsdon C, Comber. L, (2018) An Introduction to R for Spatial Analysis and Mapping (Second Edition), SAGE publishing.

3 Clifford N, Cope M, Gillespie T, French S, (2016) Key Methods in Geography (Third Edition) SAGE publishing.

4 Montello D, Sutton P, (2012), An Introduction to Scientific Research Methods in Geography and Environmental Studies (Second Edition) SAGE publishing.

5 Baxter J., Eyles J, (2004) Evaluating Qualitative Research in Social Geography: Establishing 'Rigour' in Interview Analysis, John Wiley & Sons.

6 Misra H.N., Singh V P, (Eds) (2006) Research methodology in geography: social, spatial and policy dimensions, Rawat publications.

7 Murthy, K L N (2014) Research Methodology in Geography, Concept Publishing Company.

8 Guthier, G (2010), Basic Research Methods, An Entry to Social Science Research, SAGE publishing.

9 Gomez B, Jones J P, Jones III (2010), Research Methods in Geography: A Critical Introduction, John Wiley & Sons.

10 Kitchin R, Tate N J, (2000), Conducting Research in Human Geography: Theory, Methodology and Practice, Prentice Hall.
11 Flowerdew R, Martin D, (2005), Methods in Human Geography: A guide for students doing a research project, 2nd edition, Taylor & Francis.
12 Tickell A, Sheppard E, Peck J and Barnes T (2007), Politics and Practice in Economic Geography, SAGE publishing.
13 Kothari C. R., (2004). Research Methodology: Methods and Techniques, New Age International Pvt Ltd Publishers.
14 Burkholder G J, Cox K A, Crawford L M, Hitchcock J H, (2014), Research Design and Methods: An Applied Guide for the Scholar-Practitioner, SAGE publishing.
15 Vincent J. Del Casino Jr. Mary E. Thomas Paul Cloke Ruth Panelli (2011), A Companion to Social Geography, John Wiley & Sons.
16 Michael Pacione (2013), Social Geography: Progress and Prospect, Routledge.
17 Andy Pike, Andrés Rodríguez-Pose and John Tomaney, (2003), Local and Regional Development, Routledge.
18 Bairoch, P. (1988), Cities and Economics Development: From the Dawn of History to the Present. Chicago: University of Chicago Press.
19 McCann G, McCloskey S, (2015), Key Issues in Development Studies, Rawat Publications.
20 Preston P.W, (2011), Theories of Development, Routledge.
21 Herod A, (2012), Geographies of Globalization: A Critical Introduction, Wiley Blackwell.
22 Paul H, (2012), Understanding Development, Polity.
23 Floyd F. Sabins, (1996), Remote Sensing Laboratory Manual, Kendall Hunt Pub Co.
24 George Joseph and C. Jeganathan, (2018), Fundamentals of Remote Sensing, Universities Press Pvt. Ltd.
25 Thomas Lillesand, Ralph W. Kiefer, (1979), Remote Sensing and Image Interpretation. Wiley.

6. Ph.D. Course work syllabus for Economics (40 Lectures)

Group – A (15 Lectures)

1. AMOS, Eviews and Stata
2. Estimation and interpretation of OLS; Functional form; Goodness of fit.
3. Time Series Analysis - Univariate time series; AR, MA, ARMA; Stationarity; Unit roots; Integrated Series; Co integration and Error Correction; VAR; Granger causality; Impulse response functions; Structural Breaks
4. Modelling Volatility: ARCH Models and its extension.
5. Panel Data Methods - Why panel data is necessary. Problems with panel data: attrition. Pooled OLS, random effects and fixed effects estimators.
6. Discrete and Limited Dependent Variable Models -Discrete choices; Linear probability model; Probits, Logits, Tobits

Group – B (10 Lectures)

1. Food inflation and Food Security in India
2. Industrial Growth without Employment
3. Issues related to financial sector – Reforms and Impact on Indian Economy
4. Issues concerning India's external sector policies
5. Demographic dividend in India
6. Globalization and Social Sector

Group – C (15 Lectures)

1. Dual Economy: Structure; Rural-Urban Wage Gap and Labour Turnover Model; Surplus Labour and Wage Productivity Model.
2. Informal Sector: Size and role of development; Democracy, Development, and the Informal Sector.
3. Rural Non-Farm Sector.
4. Credit Market Analysis
5. Concept of Sustainable Development
6. Valuation Methods of environmental goods.
7. Economics of renewable and non-renewable resource
8. Energy consumption, Energy security and energy pricing
9. Economic Inequality: Measurement, Interconnections of Inequality and Development.
10. Multidimensional Poverty: Theory; Issues of Measurement; Fuzzy Set Approach.

Suggested Reading:

1. Wilkinson and Bhandarkar, *Methodology and Techniques of Social Research*, Himalaya Publishing House.
2. Kothari R.C., *Research Methodology, Methods and Techniques*, New Age International Publishers, IInd revised edition, reprint 2008.
3. Cooper D. and Schindler P. *Business Research Methods*, Tata McGraw Hill. Sultan Chand & Sons.
4. Don E. Ehridge, *Rresearch Methodology in Applied Economics:* Organizing Planning and Conducting Economics Research, John Wiley and sons, April 2004.
5. Deepak Chawla and Neena Sondhi, Research Methodology Concepts and Cases, Vikas Publishing House Pvt. Ltd.-Noida, 2011.
6. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics, The World Press Private Limited.
7. Mathai, A. M. and Rathie, P.N. (1977):Probability and Statistics, Macmillan.
8. Baltagi: Panel Data Analysis
9. Wooldrige J. M: Econometric Analysis of Cross Section and Panel Data. The MIT Press, 2002.
10. Cameron, C.A. and Trivedi, P.K.: Micro econometrics: methods and applications. Cambridge U.P., 2005. (CT)
11. Cameron, C.A. and Trivedi, P.K.: Micro econometrics Using STATA. STATA Press, 2009.
12. Ruud P.A.: An Introduction to Classical Econometric Theory. Oxford U.P., 2000.
13. Greene, W.H.: Econometric Analysis. 6th Ed. Prentice-Hall, 2008.
14. Morgan, S.L. and Winship, C.: Counterfactuals and Causal Inference: Methods and Principles for Social Research. Cambridge U.P., 2007.
15. Kennedy, P.: A Guide to Econometrics. The MIT Press, 2003.
16. Jeffrey M. Wooldridge (2016): Introductory Econometrics: A Modern Approach (5^{th} edition) (Chapters 3. 4 and 6)
17. Enders, W.: Applied Econometric Time Series, Third Edition, Wiley.
18. Judge, Hill, Griffiths, Lütkepohl, Lee: Introduction to the Theory and Practice of Econometrics.
19. Johnston, J. and Dinardo, D.: Econometric Methods, Fourth Edition, McGraw-Hill, 2006.
20. Gulati, A. & Saini S. (2013): Taming Food Inflation in India > Discussion Paper No. 4, Commission for Agricultural Costs and Prices, Ministry of Agriculture, Govt. of India.
21. Sasmal ,J. (2015): Food price inflation in India : The Growing economy with sluggish agriculture , Journal of Finance, Economics and Administrative Science, Elsevier, 20(38).
22. Nicholls, W.H. (1955): 'Imperfect Competition in Agricultural Industries" in H. G. Halcrow (ed) Contemporary Readings in Agricultural Economics,
23. Sarkar, A, (1993): On the Formation of Agricultural Prices, JDE, June.
24. Sasmal, J.(2003): Agricultural Price and Price Policy and Agricultural Trade Liberalisation in India, Artha Beekshan, June, 12(1).
25. Thomsen, F.L. (1951) : Agricultural Marketing, McGraw-Hill.
26. Sikdar, S. (2006): *Contemporary Issues in Globalization: An Introduction to Theory and Policy in India*, OUP India.
27. "WTO Compatibility of Border Trade Measures for Environmental Protection*", Frequestly Asked Questions*, Centre for WTO Studies.
28. Kallummal, M. and H. Kaushwaha (2014): "Doha Negotiations and India's Trade in Environmental Goods: Analysis of NAMA Sectoral Impact, *WP No. 13*, Centre for WTO Studies, IIFI New Delhi, January.
29. Pal, P. P (2008): "Regional trade agreements and improved Market access in Developed countries: the

evidence", *EPW*, November 29.

30. Das, K. (2008), "Addressing SPS Challenges in India", *Centre for WTO Studies*, IIFI New Delhi, September.
31. Sandesera, J.C. (1992) Industrial Policy and Planning: 1947-1951, Sage Publication.
32. Sen, Rajkumar (ed): 2005, Social Sector Development in India, Deep and Deep
33. Joshi, V, and Little, I.M.D.: India's Economic Reforms: 1991-2001, OUP
34. Govt. of India: Economic Survey 2004-05.
35. Bhagwati, J. 2004; In Defense of Globalization, OUP.\
36. Tisdell, Clem and Sen, Rajkumar (ed): Economic Globalization, 2004
37. Chandra, P.: Financial Markets, Tata McGraw-Hill Education, Second edition, 2008
38. Sharan, V & Mukherjee. I. N, India's External Sector Reforms, 2001, OUP
39. Kaushik Basu – Analytical Development Economics: The Less Development Economy Revisited, The MIT Press, Cambridge (2003).
40. SugataMarjit & Meenakshi Rajeev (ed.), Emerging Issues in Economic Development: A Theoretical Perspective, OUP(2015).
41. Rose-Ackerman, S.: Corruption and Government: Causes, Consequences and Reform, Cambridge University Press (1999).
42. Misra, A. (ed.) Economics of Corruption, Oxford University Press (2005).
43. Debraj Ray- Development Economics, Princeton University Press (1998).
44. Sabina Alkire, James Foster, Suman Seth, Maria Emma Santos, José Manuel Roche, and Paola Ballon; Multidimensional Poverty Measurement and Analysis, OUP (2015).
45. Kakwani and Silber: Quantitative Approach to Multidimensional Poverty, Palgrave Macmillan (2008).
46. Ravi S. Srivastava: Asocial protection floor for India, International Labour Office, 2013.
47. PranabBardhan,: Land, Labour and Rural Povrty: Essays in Development Economics, OUP. 1984.
48. Abhijit Vinayak Banerjee, Roland Benabou, and Dilip Mookherjee. Dynamics of Poverty. OUP
49. Kolstad C D- Intermediate Environmental Economics, Oxford University Press, Second Edition, 2011.
50. Berck P and G. Helfand, :The Economics of the Environment, First Edition, Addison-Wesley, 2011.
51. Hanley N., F. Shogran and B. White: Environmental Economics in Theory and Practice, McMillan,
52. Hanley N., F. Shogran and B. White: An Introduction to Environmental Economics,OUP, 2004.
53. Pearce D.W. and R.K Turner, Economics of Natural Resources and the Environment, Harvester Wheatsheaf. 1991.
54. Stephen Smith, Environmental Economics – A very short introduction, OUP, 2011.
55. Wills Ian: Economics and the Environment, Allen and Unwin, 2007.

7. Ph.D. Course work syllabus for Physiology (40 Lectures)

1. ***Cardiovascular Physiology:*** Ischemia and reperfusion injury, Arrhythmia, Integrative cardiovascular control, Echocardiography, Angiogenesis technology.
2. ***Neurophysiology:*** Molecular basis of Schizophrenia, Alzheimer's disease, Mood disorder, Neurobehavioral studies, Neurological assessment techniques: EEG, Patch-clamp techniques.
3. ***Environmental Physiology:*** Assessment of thermal environment- hot and cold environment, thermal discomfort assessment, auditory environment and noise assessment-subjective and empirical measure, noise mapping, measuring hearing threshold.
4. ***Genetics, Molecular Biology and Biotechnology***: Linkage, Crossing over and RFLP in linkage analysis, Mapping in eukaryotes, Chromosome Mutation, Gene therapy, Genetics and Cancer, 2-D Gel Electrophoresis, MALDI, Southern, Northern and Western Blotting, RT-PCR, Micro assay, Stem cell Biology, Site – direction mutagenesis, DNA fingerprinting and foot printing, transgenesis, Recombinant DNA Technology application studies in Biotechnology.
5. ***Microbiology and Immunology***: Host microbe Interaction, Infectious diseases, epidemiological studies, Bioremediation. Immunology- a) T-cell regulation, b) B-cell regulation, c) Cytokines, Apoptosis, e) Flow cytometry, Confocal microscopy, Cell links, Knockout mice.

   Viable but Non Culturable (VBNC) State in Bacteria, Factors inducing VBNC state, VBNC state in pathogenic bacteria, Virulence and Gene Expression of VBNC cells, The concept of Microbiome, Study of Micropbiome, The Microbiome Project: Human and Earth.
6. ***Sports Physiology and Ergonomics***: Kin anthropometry, Biomechanical analysis of posture, Shoulder moment, back force-2D & 3D model. Computer aided work space design-Ergo man, Ergo space, Workspace modeling. Physiological and Psychological methods of work stress.
7. ***Endocrinology and Reproductive Physiology***: Molecular endocrinopathy at the level of receptors, molecular basis of endocrine tumors, in vitro fertilization, cytokines as hormones.
8. ***Community Health and Epidemiology***: Setting a Community Health Program, Concept of Epidemiology, Principle of Epidemiological research.
9. **Stem Cell Biology:** Introduction to Stem Cells, Reprogramming of Somatic Cells to induced pluripotent Stem cells, Application of iPS technology to Regenerative Medicine, Developmental hematopoiesis, Epigenetic regulation of stem cell fate, Niche Biology:

regulation of hematopoiesis by the nice-mediated signalling mechanisms. Cryopreservation of cells (general), Cord blood banking and long-term, storage of stem cells, FACS and its application in stem cell research, neural stem cells and differentiation.

Suggested Reading:

1. Kothari, C.R. (2008). Research Methodology: Methods and Techniques. Second Edition. New Age International Publishers, New Delhi.
2. Garg.B.L., Karadia, R., Agarwal,F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
3. Day RA (1992) How to write and publish a scientific paper. Cambridge University press. London
4. Anderson, Durston and Poole: Thesis and Assignment writing
5. R. Kumar: Research methodology – a Step-by Step Guide for beginners
6. Dawson C.: Practical Research methods:
7. Das D. and Das A.: Statistics in Physiology and Psychology. Academic publisher. Kolkata
8. Gupta S.P. (2008). Statistical Methods. 37th ed. (Rev) Sultan Chand and Sons. New Delhi. 1470 p.
9. Downine N.M: Basic Statistical Methods. New York: ¨Harper and Health Row Publishers.
10. Frank, Harry. Statistics. Concepts and Applications. Cambridge. Althoen, Steven Cambridge University.
11. Dhara P C: Computer in Biological Sciences. Academic Publisher, Kolkata
12. Leon & Leon (2202). Internet for everyone, Vikas Publishing House.
13. SPSS – Operating Manual and handbook – Latest version
14. Sinha P.K. (1992). Computer Fundamentals, BPB Publications, New Delhi.
15. De Robertis and De Robertis: Cell and Molecular Biology
16. Gupta P. K.: Cell and Molecular Biology

8. Ph.D. Course work syllabus for Physical Education (40 Lectures)

Unit-I: Structure and function of Muscle (10 Lectures):

i. Classification of muscles.
ii. Structure of muscle tissues,
iii. various theories of muscular contraction
iv. Hypertrophy of muscle in relation to physical, activity.

Unit- II: Neuromuscular Physiology and Effect of exercises (10 Lectures):
i. Neuro Motor units, Neuro muscular junction,
ii. Bioelectric potential, Muscle tone,
iii. Posture and equilibrium.
iv. Physiological Changes due to exercise and training: Effect of exercises and training in relation to oxygen dept. second wind.

Unit- III: Basics of Biomechanical Research (10 Lectures):
i. Scope of Biomechanical research
ii. Understanding of Basic Mathematical theorem applied m Biomechanical research.
iii. Kinetics and Kinematics parameters.

Unit: IV: Bio-Energetics (10 Lectures):
i. Fuel for muscular work and energy for muscular contraction.
ii. Aerobic and Anaerobic system.
iii. Anaerobic Threshold training.

Suggested readings:

1. Guyton A.C. Text Book of Medical Physiology. W.B. saunder company, Philadelphia, 1976.
2. De. Varies H.A.: Physiology of exercise for physical Education and Athletics, staples, press London.
3. Karopovich P.V.: Physiology of muscular Activity.
4. Bourne G.M. The structure and function of muscle Academic of press. London: 1972.
5. Morehouse L.E. and miller A.T. physiology of exercise. C.V. Mosbey company saint Louise 1976.
6. P.O. Astrand and K. Rodahl text-book of work physiology, M.C. graw-hill kogakusha Ltd., 1970.
7. Mathew D.K. F Fox E.L. Physiological basic of physical education and athletics. W.B. Saunders cophilaelphia,1976.
8. Katch : Exercise Physiology, Energy, nutrition and human performance-Henery kimpson U.K. 1981 .
9. Berger A.R. Applied exercise Physiology, Lea and febiger. Philadelpia, 1982.
10. Biomechanics in Sports Techniques-Hay.

11. Biomechanics: E. Riaighoaum.K.M. Barthels.

Paper – IV
Review and Project Work
Marks – 50 (Each unit 10 marks)

A. Review Work

Review work must have submitted in hard copy - A4 size paper, MS word format,12 fonts, single side print, 1.5-line spacing)

3.1 Book review: One national and one international book related to the proposed research area.

3.2 International Journal review: Two international journal articles related to the proposed research area.

3.3 National Journal review: Two referred Indian journal articles related to the proposed research area.

B. Project Work

3.4 Submission of project proposal: Submission of project report in the format as – Issue / Background information, problem statement, objectives, hypothesis, rationale, methodology, scheme of the study, literature review and references *(Student have to submit hard copy spiral binding - A4 size paper, MS word format,12 fonts, single side print, 1.5-line spacing, maximum 50 pages and a soft copy in .pdf format).*

3.5 Presentation of Project work: Power Point Presentation of project report containing Issue / Background information, problem statement, objectives, hypothesis, rationale, methodology, scheme of the study, literature review and references (*within 15 slides*).