S.NO.	Faculty	Lab Name	Revised Course	Course Name	L	T	P	C	Core/ Elective
1	MIS	4PI	MIS-4PI-1-0001	Research Methodology	1	1	0	2	Core
2	MIS	4PI	MIS-4PI-2-2201	Principles and Techniques of Mathematical Modelling	3	0	0	3	Elective
3	MIS	4PI	MIS-4PI-2-2202	Mathematical Modeling: Principles and Application	3	0	0	3	Elective
4	MIS	4PI	MIS-4PI-2-2203	Network Security and Cryptography	2	1	0	3	Elective
5	MIS	4PI	MIS-4PI-2-2204	Weather and Climate Informatics	2	1	0	3	Elective
6	MIS	4PI	MIS-4PI-3-2201	Reasoning and Quantitative Thinking	2	1	0	3	Elective
7	MIS	4PI	MIS-4PI-3-2202	Advanced Numerical Techniques	2	1	0	3	Elective
8	MIS	4PI	MIS-4PI-3-2203	High Performance Scientific Computing	2	1	0	3	Elective
9	MIS	4PI	MIS-4PI-3-2204	Introduction to Non-linear Dynamics	2	1	0	3	Elective
10	MIS	4PI	MIS-4PI-3-2205	Advanced Information Security	2	1	0	3	Elective
11	MIS	4PI	MIS-4PI-3-2206	Finite Element Method	3	0	0	3	Elective
12	MIS	4PI	MIS-4PI-3-2207	Numerical Weather Prediction	2	0	2	3	Elective
13	MIS	4PI	MIS-4PI-3-2208	Statistical Physics and its Practical Applications	3	0	0	3	Elective
14	MIS	4PI	MIS-4PI-3-2209	Advanced Self Study	0	2	4	4	Core
15	MIS	4PI	MIS-4PI-4-0001	Project Proposal	0	1	2	2	Core
16	MIS	4PI	MIS-4PI-4-0002	Review Article	0	1	2	2	Core
17	MIS	4PI	MIS-4PI-4-0003	CSIR-800 Societal Programme	0	0	8	4	Core
18	MIS	NISTADS	MIS-NISTADS-1-4401	Quantitative Research Methodology	1	1	0	2	Core
19	MIS	NISTADS	MIS-NISTADS-1-4402	Environmental History	1	2	0	3	Elective
20	MIS	NISTADS	MIS-NISTADS-2-4401	Introduction to Qualitative Research	1	0	2	2	Core
21	MIS	NISTADS	MIS-NISTADS-2-4402	Indian Economy and Policy	1	0	0	1	Core
22	MIS	NISTADS	MIS-NISTADS-2-4403	Innovation systems and development	1	0	0	1	Core
23	MIS	NISTADS	MIS-NISTADS-2-4404	Introduction to History of Science	1	0	0	1	Core
24	MIS	NISTADS	MIS-NISTADS-2-4405	Science, Technology and Innovation Policy	1	0	0	1	Core
25	MIS	NISTADS	MIS-NISTADS-2-4406	Science and Technology Systems - India and the World	1	0	0	1	Core
26	MIS	NISTADS	MIS-NISTADS-2-4407	Principle of Economics	1	0	0	1	Core
27	MIS	NISTADS	MIS-NISTADS-2-4408	Social Studies of Science: An Introduction	1	0	0	1	Core
28	MIS	NISTADS	MIS-NISTADS-2-4401	Trade and Technology	1	0	0	1	Elective
29	MIS	NISTADS	MIS-NISTADS-2-4402	Enterprise Development through Value Chains Analysis	1	0	0	1	Elective
30	MIS	NISTADS	MIS-NISTADS-3-4401	Intellectual Property Rights in the Context of Research, Innovation	1	0	0	1	Elective
31	MIS	NISTADS	MIS-NISTADS-3-4402	Global Warming: History, Trends and Politic	1	0	0	1	Elective
32	MIS	NISTADS	MIS-NISTADS-3-4403	Resource Planning & Policy (RPP)	1	1	1	1	Elective
33	MIS	NISTADS	MIS-NISTADS-3-4404	Introduction to Public Health Policy	1	0	0	1	Elective
34	MIS	NISTADS	MIS-NISTADS-3-4405	Science, Technology and Innovation Strategy	1	0	0	1	Elective
35	MIS	NISTADS	MIS-NISTADS-3-4406	An Introduction to Probability and Statistics	1	0	0	1	Elective
36	MIS	NISTADS	MIS-NISTADS-3-4407	Foundations of Mathematics	1	0	0	1	Elective
37	MIS	NISTADS	MIS-NISTADS-4-0001	Project Proposal	0	0	4	2	Core
38	MIS	NISTADS	MIS-NISTADS-4-0002	Review Article	0	0	4	2	Core
39	MIS	NISTADS	MIS-NISTADS-4-0003	CSIR-800 Societal Program	0	0	8	4	Core
40	MIS	URDIP	MIS-URDIP-1-0001	Research Methodology	1	1	0	2	Core

S.NO.	Faculty	Lab Name	Revised Course	Course Name	L	T	P	C	Core/ Elective
41	MIS	URDIP	MIS-URDIP-2-4801	Advanced Self Study	0	2	4	4	Core
42	MIS	URDIP	MIS-URDIP-3-4801	Bioinformatics	2	0	1	3	Elective
43	MIS	URDIP	MIS-URDIP-3-4802	Cheminformatics	2	0	1	3	Elective
44	MIS	URDIP	MIS-URDIP-3-4803	IP Management	2	1	0	3	Elective
45	MIS	URDIP	MIS-URDIP-3-4804	Patinformatics	2	0	1	3	Elective
46	MIS	URDIP	MIS-URDIP-3-4805	R&D Management	2	1	0	3	Elective
47	MIS	URDIP	MIS-URDIP-3-4806	Technology Management	2	1	0	3	Elective
48	MIS	URDIP	MIS-URDIP-4-0001	Project proposal writing	0	0	4	2	Core
49	MIS	URDIP	MIS-URDIP-4-0002	Review Article	0	0	4	2	Core
50	MIS	URDIP	MIS-URDIP-4-0003	CSIR-800 Societal Program	0	0	8	4	Core
51	MIS	URDIP-PGDPI	MIS-URDIP-2-4803	Introduction to IPR and Patents and Patent Legislation	2	4	0	6	
52	MIS	URDIP-PGDPI	MIS-URDIP-2-4804	International Framework	2	0	0	2	Core
53	MIS	URDIP-PGDPI	MIS-URDIP-2-4805	Patinformatics and Basics of Patent Searching	2	0	0	2	Core
54	MIS	URDIP-PGDPI	MIS-URDIP-2-4806	Searching on Patent Databases	2	0	0	2	Core
55	MIS	URDIP-PGDPI	MIS-URDIP-2-4807	Understanding Database Features	2	4	0	6	Core
56	MIS	URDIP-PGDPI	MIS-URDIP-2-4808	Advanced Patent Searching	2	0	0	2	Core
57	MIS	URDIP-PGDPI	MIS-URDIP-2-4809	Information searching in various Domains	2	0	0	2	Core
58	MIS	URDIP-PGDPI	MIS-URDIP-2-4810	Patent Analytics & Mapping and its Application	2	0	0	2	Core
59	MIS	URDIP-PGDPI	MIS-URDIP-2-4811	Patent information for Technology Planning and Management	2	4	0	6	Core
60	MIS	URDIP-PGDPI	MIS-URDIP-2-4812	Patinformatics for Patent Valuation	2	0	0	2	Core
61	MIS	URDIP-PGDPI	MIS-URDIP-2-4813	Patinformatics for R&D planning, Strategic Patenting and Perform	2	0	0	2	Core
62	MIS	URDIP-PGDPI	MIS-URDIP-2-4814	Patinformatics for Patent Strategy and Portfolio Management	2	4	0	6	Core

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-1-0001**			
Course Title	**Research Methodology**			
Credit Distribution (L-T-P-C)	1	1	0	**2**
Core/Elective	**Core**			

Course Description:

Introduction, Research terminology and scientific methods, different types and styles of research, role of serendipity, creativity and innovation, Scientific and critical reasoning skills, art of reading and understanding scientific papers, literature survey. Measurements in research - primary and secondary data. Quantitative methods and data analysis, Qualitative analysis, Communicating research results. Designing and implementing a research project. Ethics in research, Plagiarism, Case studies.Laboratory safety issues – lab, workshop, electrical, health & fire safety, safe disposal of hazardous materials.

Role & importance of communication, Effective oral and written communication. Technical report writing, Technical/R&D proposals, Research paper writing, Dissertation/Thesis writing, Letter writing and official correspondence. Oral communication in meetings, seminars, group discussions; Use of modern aids; Making technical presentations.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-2-2201**			
Course Title	**Principles and Techniques of Mathematical Modelling**			
Credit Distribution (L-T-P-C)	3	0	0	**3**
Core/Elective	**Elective**			

Course Description:

This course will provide an overview of principles and techniques of mathematical modelling used by engineers and scientists with a bias to fluid mechanics. The following topics will be discussed:

1. Mathematical modelling. What is modelling? Properties of a model. Why do we model? Some examples. The four paradigms and relevance of modelling.
2. Order of magnitude analysis. Dimensional arguments.
3. Complex variable. Power series. Branch points.
4. Vectors and tensors. Linear vector spaces. Matrix theory.
5. Vector fields, their Divergence and Curl. Classification and representation of vector fields.
6. Numerical methods. Numerical differentiation and integration. Interpolation. Initial and boundary value problems. Euler and Runge-Kutta methods. Multi-step methods.
7. Dynamics: Geometric ideas.
8. Model equations in fluid mechanics.

Recommended Books

1. Bender, E. A. An Introduction to Mathematical Modeling. John Wiley and Sons. 1978.
2. Goldreich, P., Mahajan, S., Phinney, S. Order-of-Magnitute Physics: Understanding the Wold with Dimensional Analysis, Educated Guesswork, and White Lies. 1999.
3. Nearing, J. Mathematical Tools for Physics. www.physics.miami.edu/nearing/mathmethods/. 2003.
4. Koonin, S. E. Computational Physics. Benjamin/Cummings. 1986.
5. Golub, G. H., Ortega, J. M. Scientific Computing and Differential Equations: An Introduction to Numerical Methods. Academic Press. 1992.
6. Aris, R. Mathematical Modelling Techniques. Dover. 1995.
7. Abraham, R. H., Shaw, C. D. Dynamics: The Geometry of Behavior. Addison-Wesley. 1992.
8. Aris, R. Vectors, Tensors and the Basic Equations of Fluid Mechanics. Dover. 1962.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-2-2202**			
Course Title	**Mathematical Modeling: Principles and Application**			
Credit Distribution (L-T-P-C)	3	0	0	**3**
Core/Elective	**Elective**			

Course Description:

Steady field and potentials (Laplace, Poisson and biharmonic equations)
Gravitational potential, continuous distribution of mass; Electrostatics, charge free, point, surface and volume chargers; electrostatics, point, surface and volume sources; hydrostatics, Bernoulli equation, Stokes flow, Couette flow, Poiseuille Flow; Steady heat flow, point and distribute sources, stratified media; examples for earth system science using analytical and numerical methods.
Diffusion of fields (Heat equation)
Transient heat conduction, point, surface and volume sources, phase change, stratified media; Electromagnetic diffusion, sources, stratified media; pore pressure diffusion, sources, stratified media; stress diffusion in elastic/viscous media; Chemical diffusion, sources and chemical reactions; examples from earth system science using analytical and numerical methods.
Waves fields (wave equation)
Electromagnetic harmonic waves, stratified media, waveguides, antenna; transient electromagnetic waves, sources, stratified media; harmonic elastic waves, body and surface waves, sources and free oscillations; harmonic waves in fluid media, sources, stratification; transient waves, sources in continuous media; examples from earth system science using analytical and numerical methods.
Nonlinear and inverse problems
Reaction diffusion equation, travelling wave solution; population growth and dispersion; filtration equation; solitary waves; barotropic and baroclinic instabilities; parameterized climate models; parameter estimation in underdetermined systems, regularization; examples from earth system science using analytical and numerical methods.
Recommended Books
Aster, R., Borchers, B. and Thurber,C. Parameter Estimation and Inverse Problems, Elsevier, 2005.
Holton, J. Introduction to dynamics meteorology, Elsevier 2004
Jaupart C and Mareschal, J.-C. Heat generation and transport in the earth, 2011, CUP
Marshal and Plumb, Atmosphere, ocean and climate dynamics, Elsevier, 2008
Parker, DF, Fields Flows and Waves, An introduction to continuum models, Springer, 2003
Plawsky, J. Transport phenomena fundamentals, CRC press, 2010.
Torcotte and Schubert, Geodynamics, Cambridge University Press, 2002

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-2-2203**			
Course Title	**Network Security and Cryptography**			
Credit Distribution (L-T-P-C)	2	1	0	**3**
Core/Elective	**Elective**			

Course Description:

Introduction to Computer Security
Threats of viruses, worms, malicious codes, etc., models of propagation and their epidemic spread, dos attacks, defenses against hacking, DDoS
Theory, foundations, and applications of modern cryptography. One-way functions; encryption; authentication; symmetric cryptography, asymmetric cryptography: message authentication codes, multi-party cryptographic protocols, key exchange and applications; cryptanalysis of cryptographic primitives
Intrusion Detection and Network Security
Lab Courses on Security Tools
Suggested Readings
1. William Stallings, “Cryptography And Network Security – Principles and Practices”, Prentice Hall of India, Third Edition, 2003.
2. Bruce Schneier, “Applied Cryptography”, John Wiley & Sons Inc, 2001.
3. Charles B. Pfleeger, Shari Lawrence Pfleeger, “Security in Computing”, Third Edition, Pearson Education, 2003.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-2-2204**			
Course Title	**Weather and Climate Informatics**			
Credit Distribution (L-T-P-C)	2	1	0	**3**
Core/Elective	**Elective**			

Course Description:

Earth system overview: Introduction to geography and natural resources, Overview of fundamentals of Earth's climate, including greenhouse effect, water and chemical cycles, outstanding features of atmospheric and ocean circulation, and feedback between different system components. Exciting and contentious scientific puzzles of climate system, like causes of ice ages, greenhouse warming, IOD, El niño etc.

Observation, analysis, modelling, forecasting and validation: Statistical analysis in climate research: probability theory, Distribution of climate variables, concepts of statistical interference, statistical test of hypothesis, analysis of atmospheric circulation problems, Forecast quality evaluation.

Application of weather informatics: Real time flood forecasting, landslide prediction, forest fire, precision agriculture: planting and fertilizer application, demand for electricity and gas, aviation etc.

Climate Change and Climate Modeling: Global environmental issues in climate change due to human activities or natural climate variations. Climate and environmental change, understand how physical geography techniques can help quantify and understand these changes, learn how to work with climate data and simple models, analyze the potential impacts of environmental change on a range of sectors including agriculture, food, forestry, water resources, energy usage, rapid change caused by natural hazard processes and human health, and discuss potential mitigation and adaptation options.

Software Lab: Introduction to basic data analysis tools. Survey of numerical methods employed in atmospheric and related sciences: theory, application, and programming.

Recommended Books

1. Environmental Issues: An Introduction to Sustainability, 3/E by Robert L. McConnell and Daniel C. Abel
2. Carson, R. (2002). Silent Spring, Boston: Houghton Mifflin Company.
3. Harris, J.M. (2006). Environmental and Natural Resource Economics, 2nd edition, Boston: Houghton Mifflin.
4. Meadows, D.H. et al., (2004). The Limits to Growth: the 30-year Update, The Chelsea Green Publishing Company.
5. Perman, R., May, Y., McGilvray, J. and Common, M. (2003). Natural Resource and Environmental Economics, 3rd edition, Harlow: Pearson Education.
6. Statistical analysis in climate research By Hans von Storch, Francis W. Zwiers.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-3-2201**			
Course Title	**Reasoning and Quantitative Thinking**			
Credit Distribution (L-T-P-C)	2	1	0	**3**
Core/Elective	**Elective**			

Course Description:

Reasoning1-Philosophy2-Science3: the eternal cycletowards framing significant questions and validating knowledge through examples4
Analysis of valid and invalid reasoning through examples such as syllogism5
Enquiry in the method (?) of establishing knowledge(science) through analysis of Aristotle's Inductive-deductive schema and its continual refinement through the ages to Popper's falsification criteria.
An understanding of the validity and value of Induction through analysis of Mathematical Induction and exploration of 'inductive processes' discernible in the road to some key scientific discoveries
An exploration of the development chain of some key concepts such as the definition of a 'number'- from Peano to Frege - as an example of relentless march towards bridging the chasm between consistency and completeness. Self study to look for and explain other examples6
Symbolic Logic: its journey from Leibnitz's prescient programme through a long refinement by Frege, Cantor, Turing and others
The explosive illumination of science coupled to mathematics: quantitative verification, prediction, engineering and systems design, algorithmic explorations.
Notes
1. Deduction from plausible ideas or propositions
2. Scrutiny of methods, procedures bases and criteria for their logical validity as well as of the way we use concepts
3. Empirically validated knowledge that remains tentative till supplanted by new paradigms
4. This cycle will be exemplified by analyses of the origin of ideas and hypotheses, and their evolutionary journey towards refinement, and replacement by revolutionary new Ideas: The Phlogiston theory, Newton's constant Universe, the Ether theory, the quantum theory etc.
5. These will be worked examples and include exercise in the formulation of valid and invalid syllogistic reasoning.
6. This approach will be followed throughout

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-3-2202**			
Course Title	**Advanced Numerical Techniques**			
Credit Distribution (L-T-P-C)	2	1	0	**3**
Core/Elective	**Elective**			

Course Description:

Ordinary Differential Equations:
Initial Value Problems: Single step methods, Multi step methods
Boundary Value Problems: Shooting Method, Finite Difference Methods, Finite Element Method
Partial Differential Equations:
Finite Difference Discretization, Finite difference treatment of 2nd order nonlinear PDE of parabolic, elliptic types, Hyperbolic problems
Higher Order Methods: Spectral Method, Pesudospectral Method
Recommended Books:

• Numerical Methods for Scientific and Engineering Computation– M.K.Jain, S.R.K.Iyengar and R.K.Jain, New Age International Publishers
• Computational Methods for Partial Differential Equations– M.K.Jain, S.R.K.Iyengar and R.K.Jain, New Age International Publishers
• Numerical Methods for Engineers and Scientists- Joe D. Hoffman, McGraw-Hill, Inc

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-3-2203**			
Course Title	**High Performance Scientific Computing**			
Credit Distribution (L-T-P-C)	2	1	0	**3**
Core/Elective	**Elective**			

Course Description:

Modern computer architectures, Programming and Tuning Software, Shared-Memory Parallel Processors, Scalable Parallel Processing, Scientific data formats, Open source application software

Basic concepts in parallel computing, parallel algorithms, Introduction to message passing and MPI programming, embarrassingly parallel problems, Problem decomposition, graph partitioning, and load balancing, introduction to shared memory and OpenMP programming techniques, parallel direct and iterative methods, programming on different parallel architectures, applications relevant fields, Debuggers

HPC best practices, Linux shell programming, sequential programming, compiler optimization, Multi-processor parallel programming, benchmarking and performance evaluation on different architecture, Visualization of different data formats.

Recommended Books

1. High Performance Computing, Kevin Dowd, O'Reilly Series, 1993.
2. Introduction to High-Performance Scientific Computing ©2010 (Victor Eijkhout)
3. High Performance Computing For Dummies, Douglas Eadline, Wiley Publishing, Inc.
4. High Performance Computing: Paradigm and Infrastructure, L. Yang and M. Guo, ohn Wiley.
5. Designing and Building Parallel Programs, Ian Foster, Addison Wesley, 1995
6. MPI: The Complete Reference, Marc Snir, Steve Otto, Steven Huss-Lederman, David Walker, Jack Dongarra, The MIT press, 1996
7. How to write Parallel Programs, A first Course, By Nicholas Carriero and David Gelernter, The MIT press, 1992

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-3-2204**			
Course Title	**Introduction to Non-linear Dynamics**			
Credit Distribution (L-T-P-C)	2	1	0	**3**
Core/Elective	**Elective**			

Course Description:

Introduction/Phase Space, Plane and Portraits : Linear Systems and their classification;Existence and uniqueness of solutions; Fixed points and linearization; Stablility of equilibria; Pendulum Oscillator,Dufing oscillator,Lindstedt`s method; Conservative and reversible systems.
Limit cycles: The Van der Pol oscillator, Method of averaging; Relaxation oscillators; Weakly Nonlinear Oscillators; Forced Duffing oscillator, method of multiple scales; Forced Van der Pol oscillator,entrainment, Mathieu`s equation, Floquet Theory, Harmonic Balance.
Bifurcations: Saddle-node,transcritical,and pitchfork bifurcations; Center manifold theory; Hopf bifurcation; Global bifurcations; and Poincare maps.
Chaotic Dynamics : Lorentz equations; Lorentz map ; Logistic map; Lyanpunov Exponents; Fractal sets and their dimensions; Box ,point wise and correlation dimensions; Strange attractors; Forced two-well oscillators
Time Series Analysis: State space approach
Recommended Books

1. Julien C.Sprott , “Chaos and Time-series Analysis”, Oxford University Press 2003;
2. Mark Shelhamer, “Nonlinear Dynamics in Physiology: a State Space Approach”, World Scientific, 2007
3. Edward Ott, “Chaos in Dynamical Systems”, Cambridge University Press, 1993
4. K.T.Alligood, T.D.Sauer, and J.A.Yorke, “CHAOS-An introduction to Dynamical Systems”, Springer, 1996
5. Steven H. Strogatz, “Nonlinear Dynamics and Chaos” Indian edition published by Levant books, 2007

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-3-2205**			
Course Title	**Advanced Information Security**			
Credit Distribution (L-T-P-C)	2	1	0	**3**
Core/Elective	**Elective**			

Course Description:

Divisibility, Euclidean Algorithm, Congruence's, Finite Fields, Quadratic Residues and Reciprocity, Primality algorithm, One-way and Trapdoor Functions, Stream Ciphers, Pseudo- Random Number Generators, Block Ciphers and Modes of Operations, Data Encryption Standard.

Private Key Encryption, Public Key Encryption, RSA Cryptosystem, Rabin's Public Key Cryptosystem, Knapsacks, Message Authentication and Hash Functions, Digital Signatures, RSA Digital Signature Scheme, El Gamal's Scheme, Rabin's Scheme.

Key Distribution, Diffie-Hellman Secret Key Exchange, Two-Party and Multi-Party Protocols, Simultaneous Secret Exchange Protocol, Secret Sharing, Neural and Quantum cryptography.

Cryptanalysis of cryptographic primitives and protocols, such as by side-channel attacks, differential cryptanalysis, or replay attacks; and cryptanalytic techniques on deployed systems etc.

Security protocols at application level, Socket layer and Network layer, Virtual private networks.

Suggested Readings

• Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C, Second E/d, John Wiley & Sons, 1996.
• William Stallings, Cryptography and Network Security: Principles and Practice, Second Edition, Prentice Hall, 1998.
• Neal Koblitz, A Course in Number Theory and Cryptography, Springer-Verlag.
• A. J. Menezes, P. C. van Oorshot and S. A. Vanstone: Handbook of Applied Cryptography, CRC Press.
• Shafi Goldwasser, Mihir Bellare, Lecture Notes on Cryptography. www.cse.ucsd.edu/~mihir/papers/gb.html
• O. Goldreich, Foundations of Cryptography: Basic Tools, Cambridge University Press.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-3-2206**			
Course Title	**Finite Element Method**			
Credit Distribution (L-T-P-C)	3	0	0	**3**
Core/Elective	**Elective**			

Course Description:

Approximate solution of linear differential equations -- Weighted residual techniques. Collocation, Least Squares and Galerkin methods. Use of piecewise continuous approximation functions. Basis of Finite Element Method. Formulation of element level equations and assembly into system level equations. One dimensional example problems.

Elements of Variational calculus. Minimisation of a functional. Principle of minimum total potential. Piecewise Rayleigh - Ritz method and FEM. Comparison with weighted residual method.

Two dimensional finite element formulation. Isoparametry and numerical integration.

Finite element formulation for transient dynamic problems. Algorithms for solution of equations.

Recommended Books

• Bathe, K. J., Finite element procedures in Engineering Analysis, Prentice Hall of India, 1990.

• Cook R.D., Malkus. D. S., Plesha M. E. and Witt R. J, Concepts and Application of Finite Element Analysis, 4th Ed., John Wiley, 2005.

• Huebner K. H., Dewhirst D. D., Smith D. E. and Byrom T. G., The Finite Element Method for Engineers, John Wiley, New York, 2004.

• Reddy J. N., An Introduction to the Finite Element Method, 3rd Ed., Tata McGraw Hill, New Delhi, 2005.

• Seshu P., Finite Element Analysis, Prentice Hall of India, 2003.

• Zienkiewicz, O. C., and K. Morgan, Finite elements and approximation, John Wiley, 1983.

• Zienkiewicz O. C, Taylor R. L. and Zhu J Z., The Finite Element Method: Its Basis and Fundamentals, 6th Ed., Elsevier, 2005

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-3-2207**			
Course Title	**Numerical Weather Prediction**			
Credit Distribution (L-T-P-C)	2	0	2	**3**
Core/Elective	**Elective**			

Course Description:

Governing equations - Numerical representation–numerical stebility-Computational grids - Vertical Coordinates - Sub-gridscale processes (parameterizations)- Data assimilation- Assimilation techniques: optimal interpolation, 3 and 4 dimensional variational data assimilation, etc.-Widely used numerical weather prediction models, their construction and application to forecasting and data assimilation - Global vs. Limited Area Models –Coupled models- Post- processing of model output-Gridded Forecast Verification and Bias Correction - Downscaling of numerical model outputs - Ensemble Forecasting

Recommended Books:

Jean Coiffier 2011: Fundamentals of Numerical Weather Prediction, Cambridge University Press, 368 pp. E. Kalnay, 2002: Atmospheric Modeling, Data Assimilation and Predictability, Cambridge, 364pp.

R. A. Pielke, 2002: Mesoscale Meteorological Modeling, 2ndEd., Academic, 676pp. G. J. Haltiner and R. T. Williams, 1980: Numerical Prediction and Dynamic Meteorology, 2ndEd., Wiley, 477pp.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-3-2208**			
Course Title	**Statistical Physics and its Practical Applications**			
Credit Distribution (L-T-P-C)	3	0	0	**3**
Core/Elective	**Elective**			

Course Description:

Most Emergent (sudden appearance at some stage of evolution) phenomena in Physical, social, industrial and environmental arenas are the integral result of a host of interacting processes at varying space and time scales, and are therefore inherently stochastic. The principal challenge in dealing with such phenomena lies in our ability to reliably estimate the Canonical states of a composite system required both for enhancing our understanding of the critical stages preparatory to their emergence as well as for designing resilient mitigative measures to minimize heir adverse impacts, if any. The concepts and methodologies of Statistical Physics open up illuminating analytical approaches to addressing a host of s problems related to such emergent phenomena: Atmospheric and ocean eddies, earthquakes, epidemics, financial market crashes, to name a few. It is accordingly proposed to design and deliver a course on STATISTICAL PHYSICS AND ITS PRACTICAL APPLICATIONS as a component of the AcSIRprogramme. The following is a first cut statement of course content which would form the basis for a more detailed and more evocatively addressed context that would subsequently be brainstormed and honed.

Course Contents:

1. Statistical methods: random variables, random functions, distributions, random walk, limit theorems
2. Statistical physical systems: Microscopic state of classical and quantum system, fundamental postulates of statistical mechanics, ergodic theorem
3. Microcanonical ensembles, thermal and mechanical interaction between to microscopic systems, connection between microcanonical ensemble and thermodynamics, classical monatomic gases
4. Canonical ensemble: Einstein solid, particles with two energy levels, Boltzmann gas
5. Classical gas in canonical formalism: Ideal monatomic gas, Maxwell-Boltzmann distribution, partition function, equipartition of energy, classical monatomic gas of particles
6. The grand canonical and pressure ensembles: pressure ensemble, the grand canonical ensemble
7. Phase transition and critical phenomena: Simple fluids. Van der Wall's equation, Landau phenomenology
8. The Ising model: Exact solution in one dimension, mean field approximation for the Ising model, The Curie-Weiss model, The Bedther-Peierls approximation
9. Scaling theories and the renormalization group: scaling theory of thermodynamic potentials, scaling of the critical correlations, The Kadanoff construction, Renormalization of iIsing model, The general scheme of the renormalization group
10. Nonequilibrium phenomena: Boltzmann's kinetic equation, BBGKY hierarchy, Brownian motion, Langevin equation, The Fokker-Plank equation, the master equation, the kinetic Ising equation, the Monte Carlo method
11. Porous media: Relating heat, mass balance and momentum at pore scale to watershed, environmental applications
12. Data-driven modeling using statistical physics methods in nonlinear and multiscale systems: earthquakes, atmospheric instabilities, epidemics etc.

Books:

Salinas, SRA,. Introduction to Statistical physics, Springer, 2004. Huang, K. Statistical mechanics, J Wiley, 1987 Chandler, D. Introduction to modern statistical mechanics, Oxford Univ Press, 1987 Honerkamp,J. Statistical physics, Springer, 2002.65

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-3-2209**			
Course Title	**Advanced Self Study**			
Credit Distribution (L-T-P-C)	0	2	4	**4**
Core/Elective	**Core**			

Course Description:

Aims to train the student on learning, on one's own, topics that are not formally taught in a course. This would involve primarily three components - collection of relevant literature on a chosen topic, organization of relevant material into a written report based on candidate's own critical understanding and finally presentation of the findings in front of wide audience in the form of a seminar. Thus communication skills are also expected to be honed up.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-4-0001**			
Course Title	**Project Proposal**			
Credit Distribution (L-T-P-C)	0	1	2	**2**
Core/Elective	**Core**			

Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-4-0002**			
Course Title	**Review Article**			
Credit Distribution (L-T-P-C)	0	1	2	**2**
Core/Elective	**Core**			

Course Description:

Preparation of one review article on specific research area of the student.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-4PI, Bengaluru**			
Course Nomenclature	**MIS-4PI-4-0003**			
Course Title	**CSIR-800 Societal Programme**			
Credit Distribution (L-T-P-C)	0	0	8	**4**
Core/Elective	**Core**			

Course Description:

The students have to undertake a project in rural area for 6-8 weeks in line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S & T inventions.
Alternatively students admitted at URDIP will be permitted to undertake one of following activities:
Create a database of patents which have come into public domain (Expired Patents, Non-jurisdiction Patents, Patents not granted, abandoned applications and Invalid Patents). This database then can be used to Support CSIR-800 programme to solve societal problems quickly. Similar database can also be used to support MSME sector as most of them use old techniques of production and outdated machinery and equipment.
The priority will be the areas already identified and referred by the Coordinator of CSIR-800 programme or the laboratories involved in CSIR-800 programme. Based on the identified areas and needs, student will build a problem/subject specific database and share it with scientists/technologists working on the particular project.
Alternatively, problem will be chosen from one of the clusters identified under the CSIR Cluster Innovation programme.
An opportunity assessment study or a techno-economic survey that will benefit rural economy.
Students will choose the topics in consultation with Doctoral Advisory Committee (DAC).

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-1-4401**			
Course Title	**Quantitative Research Methodology**			
Credit Distribution (L-T-P-C)	1	1	0	**2**
Core/Elective	**Core**			

Course Description:

Objective:
The purpose is to make students capable in identifying research questions and formulating hypotheses clearly and accurately; in context of a research issue. This would help them in identifying proper data collection and analysis techniques. This will be followed by providing them thorough understanding of standard quantitative techniques.
Topics & Subtopics:
1. Introduction (1.30 Hrs.)
• Quantitative data principals
• Types of data-Binary, nominal, interval, ratio, ordinal
• Inferential statistics
• Descriptive statistics
• Population and parameter
2. Sampling (1.30 Hrs.+ 1.30 Practical/Tutorial)
• Sample and Statistics
• Importance of sampling
• Sample Size Determination
3. Sampling Techniques
• Non probability Sampling Techniques
• Convenience Sampling
• Judgmental Sampling
• Quota Sampling
• Snowball Sampling
• • Probability Sampling Techniques
• Simple Random Sampling
• Systematic Sampling
• Stratified Sampling
• Cluster Sampling
4. Hypotheses Formulation and Testing (1 hr.+1.30 hr Practical/Tutorial)
• Definition of Hypotheses
• Null and Alternative Hypotheses
• Critical Z values and Rejection regions
• Z-Table for Normal distribution
• Two Tailed Test
• Right Tailed Test
• Left Tailed Test
5. ANOVA (1 hr.)
• Principal behind ANOVA
• Sum of Squares
• Mean Sum of Squares
• ANOVA Table
6. Regression (1 hr.)
• Simple Regression And Correlation
• Simply linear regression Model
• Multiple regression
1. Chi Square Test (1 hr.)
2. Factor Analysis (1 hr. + 1.30 hr. practical/tutorial)

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-1-4402**			
Course Title	**Environmental History**			
Credit Distribution (L-T-P-C)	1	2	0	**3**
Core/Elective	**Elective**			

Course Description:

Objectives

The course will introduce students to the principles and methods of interdisciplinary research for understanding the ever-evolving convergence of science, society and environment. The course will help students to understand and analyze changing human use/abuse of natural resources on the one hand and also to examine the human understanding and appreciation of the dynamics of natural systems. The main focus will be on the role of culture, ethics, social demands, economy and technology on resource use patterns at different intervals of human history.

Topics and Sub-Topics

1. Society and Environment in the Ancient World
2. Collapse of Civilizations: Environmental Causes
3. Colonialism, Capitalism and Environment
4. Global Warming: Myth or Reality
5. Environmental Movements
6. International Environmental Negotiations/Agreements.

The course will be a mixture of lectures, followed by guided reading, discussion and debate in the seminar sessions. In the first year of the course, students will be taught the basic theoretical and thematic subject issues. The method of delivery will be term papers, group discussion, seminar presentation and dissertation

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-2-4401**			
Course Title	**Introduction to Qualitative Research**			
Credit Distribution (L-T-P-C)	1	0	2	**2**
Core/Elective	**Core**			

Course Description:

Objective:
The objective of the course is to provide students deep insight of research methodology in context of social science research. Practical illustrations from the projects done by the faculty will also be given by explaining background reasons for adopting a particular technique.
Topics & Subtopics:
1. Introduction (1.30 Hrs.)
• Types of research
• Pure research
• Applied research
• Policy research
• Action research
• Model for research (Examples of each type of research)
• Characteristic of Qualitative Research
• When to use qualitative research
• Designing a qualitative study
2. Approaches to Qualitative research (1.30 Hrs. + 3 Hr. Practical/Tutorial)
 Narrative research
• Types of narrative research
• Procedures for conducting narrative research
• Phenomenological research
• Types of phenomenology
• Procedures for conducting phenomenological research
• Grounded theory research,
• Types of grounded theory studies
• Procedure for conducting grounded theory research
• Challenges, ethnographic research
• Types of ethnographies
• Procedure for conducting ethnographic study
• Case study research
• • Procedure for conducting a case study
• Choosing an approach to qualitative research.
• Qualitative data principals
3. Conducting interview (1.30 Hr. + 1 Hr. Practical/Tutorial)
• Unstructured Interviews
• Semi structured interview
• Structured interview
4. Sociometry(1 Hr.)
5. Validity (1 Hr.)
• Types of Validity,
• Internal validity,
• Construct validity
• External validity
• Statistical validity
• Threats to validity
• 6. Non Experimental research (2 Hrs. + 1.30 Hr Practical/Tutorial)
 Observational

- Naturalistic observation
- Survey research
- Designing a questionnaire
- types of questions
- Methods of administering questionnaire
- Problems of response rate
- Data analysis

7. Experimental research (1 Hr.)
- Attributes and variables
- Cause and effect
- Control
- Types of experimental design

1. Quasi experimental (30 Min.)
2. Ex post facto research.(30 Min)

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-2-4402**			
Course Title	**Indian Economy and Policy**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Core**			

Course Description:

Objective:
The course intends to provide the students an overview of the Indian economy, its development and evolutionary process since independence.
Topics & Subtopics:
1. State of Indian economy at the time of independence with a brief discussion on colonial era
2. Planning Era
- Need for planning
- Planning Strategies under different plans
- 3. Agricultural Polices
- Policy frames in the 1950s and the early 1960s
- Policy shifts in late 1960s – green evolution strategies
- Policy changes in the 1980s – diffusion of green revolution across crops, regions
- Land holding structure, tenancy and technology change
- Credit and insurance
- Research and development
- Current issues of importance
- 4. Industrial Policies
- Policy frames in the 1950s to 1970s
- Structural retrogression of Indian Industries in mid 1960s
- Policies for SMEs and large industries
- Economic liberation and end of license raj
- Indian industries in the globalized world
- 5. Structure and Growth of the Service Sector
- 6. Policy support for technology diffusion and innovation
- 7. The External Sector
- Indian Trade Policy and Development
- India’s Balanced of Payments – Emerging issues
- Openness and FDI flows

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-2-4403**			
Course Title	**Innovation systems and development**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Core**			

Course Description:

Objective: This course is to help students develop their analytical skills in understanding and enabling innovation to meet development goals. It is designed with the core courses, tutorials and one practical exercise (a case analysis or project) that can be selected by the students depending on their disciplinary orientation, context or work experience.

The use of innovation systems framework for planning and its operationalization for development demands theoretical insights and analytical competencies. This course will give students a clear understanding about the difference between (a) innovation systems,

(b) technology and society, and (c) social construction/mode of knowledge production. That the components and systems relationships – interactive learning, the academic (disciplinary) contexts and policy contents, and processes involved in the analysis of each of these are different, will be made explicit. Despite increasing currency of the term innovation (as seen in India in the past three years or so), many continue to use the term as synonymous and the epistemic equivalent of technology or technology generation and diffusion. Through the lectures and tutorials in this course, the students get to use the innovation systems theoretical framework and the analytical instruments offered by several disciplines – economics, sociology, anthropology and political science in particular, to understand and enable innovation that can lead to development outcomes. The normative positions being more explicit in the innovation systems framework, helps the students see and question the assumptions made in mainstream economics and technological or technology commercialization studies therein. Covering a range of economic – Marshallian neo-classical and Marxist historical materialism, Schumpeterian evolutionary, Veblenian/Kapp institutional and evolutionary, and sociological – Feenbergian critical theory, Latourian social construction vs. Bijker-Winner social determinism, theories and analytical tools, the course sets a terrain in which the student can use the analytical narrative of the innovation systems framework to achieve development goals.

In the main semester, besides 50 hours of lecture, the course will have two tutorials. Each lecture (3 hours each) will also include discussion of the reading material. The students will be taught the basic skills of building an annotated bibliography, the design of a conceptual framework, etc.

Topics and sub-topics

1 Introducing Innovation Systems – basic definitions, framework (1 Lecture)

2 Distinguishing features – Components and processes in Innovation systems (1 Lecture)

3 Differences between innovation systems framework and technology and society (1 Lecture)

Major questions asked – debate on the use in planning (interventions or investments) for development (1 Lecture)

• Tutorial – students read and review in class three major books in Innovation Systems literature

1 Development economics – Innovation systems theory – as two estates (1 Lecture)

2 From technology black-box to economics of S&T to priority setting to science policy prescriptions – an evolutionary account of knowledge and economic growth (1 Lecture)

3 Evolutionary/Institutional economics – theoretical foundation of innovation systems (1 Lecture)

4 Macro-economics of technological change – Processes of technological and institutional innovation; structural and functional changes in components of the innovation system (1 Lecture)

5 Tutorial – students explore 3 cases of developed vs. developing countries-discuss specific macro-economic and technological change processes, identify institutional and policy changes in the cases

6 State and markets – Innovation trajectories and options from history (1 Lecture)

7 Investing in and planning for S&T – industrial, agricultural and service sector innovation systems (1 Lecture)

8 India's development experience through an innovation systems lens: a vicious circle of poverty and impeded innovation (1 Lecture)

9 Institutional setting – laying the ground rules -Mahalanobis-Nehru, Pitroda-Gandhi, and the Dhawans, Sivaramans, Pothens and Kalams (1 Lecture)

10 Socio-technological paradigms and paradigm shifters. Climate change vs. the MDGs (1 Lecture)

11 Re-cap + India's policies and investments in technology generation and extension – for major development sectors (1 Lecture)
12 Current development crisis – the digital divide, risk perceptions and occurrence, GM
13 crops, low cost vaccines/health care, small firms vs. Multinationals (1 Lecture)
14 Eco-friendly and gender sensitive innovation systems for sustainable development; India's future (1 Lecture)

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-2-4404**			
Course Title	**Introduction to History of Science**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Core**			

Course Description:

Objectives

The course in history of science provides interdisciplinary training to research students, policy planners and science administrators for a research career or in the executive wing of state administration. It will introduce students to the principles and methods of interdisciplinary research for understanding the evolution of science as a knowledge system and state apparatus from the ancient times. It will help students to understand and appreciate the social stimulus/constraints on science, social functions of science, and the impact of science on society and economy.

Topics and sub-topics

The course in history of science will consist of the following thematic topics:

1. Science & Technology in the Ancient World
2. Science & Technology in Pre-Colonial India
3. Rise of Modern Science & Western Colonial Expansion
4. Colonial Science: Methods and Processes
5. Scientific Institutions and Scientific Community
6. Science Education and Research

The course will be a mixture of lectures, followed by guided reading, discussion and debate in the seminar sessions. In the first year of the course, students will be taught the basic theoretical and thematic subject issues. The method of delivery will be term papers, group discussion, seminar presentation and dissertation.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-2-4405**			
Course Title	**Science, Technology and Innovation Policy**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Core**			

Course Description:

Objective
The objective of the course is to familiarize students with various dynamics of technological innovation an element of organization and national competitiveness. At the end of the course students shall be able to understand various aspects of developing a technology strategy at micro and macro level.
Course Contents
Definitions, concept of technology, technology as a resource, scope of technology management, role of technology in competitiveness enhancement, path from invention to commercialization-case studies; definition and concept of innovation, types of innovations, challenges for innovation, market potential of a technological innovation, life span of a technology: innovation-pilot production- diffusionsubstitution; technology transfer models, dimensions, routes and features of technology transfer, technology licensing, patent analysis; factors determining appropriate technology, formulating technology policy-at organizational and national level, role of socio-economic goals in determining technology policy; nature of technology change- incremental and radical innovations, technological revolutions; technology forecasting and innovation, approaches to technology forecasting, methods of technology forecasting and their comparison; difference in technology generation and development, stages and elements involved in technology generation process; concept of technology absorption, constraints in technology absorption, Indian experience in technology absorption, Government efforts in import, absorption, development and diffusion of technologies; overview of trade and industrial policy, incentives and support mechanisms, S & T policies of select developed countries; financial aspects in establishing a technology based enterpriseventure capital, working capital, capital markets; analyzing and preparing case studies.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-2-4406**			
Course Title	**Science and Technology Systems - India and the World**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Core**			

Course Description:

Objective:

The course in "Science and Technology Systems in India visa-vis world" provides interdisciplinary training to research students, policy planners and science administrators for a research career . It will introduce students to the dynamics and understanding for evolution of S&T systems for economic development and poverty alleviation in India and across the world. The course will help students to look into historical glimpses on advancements of scientific and technological knowledge which made possible the significant reduction of poverty and improvements in the quality of life in both developed and developing countries throughout the 20th century which further helps the students to understand the close link between economic growth and the strategic approaches of S&T system/policies. The course will focus on the S&T system of India which besides the core S&T milieu embraces large number of economic sectors as well as social dimensions. The course will provide the scope to study and analyze the following: (1) social and economic development through progress and applications of S&T; (2) management of S&T infrastructure (3) governance of S&T system (4) modes of funding

Topics and Subtopics

1 Science and Technology Policies-Comparative Study/analysis

2 India's Science and Technology Policy and its influence on technology development (Historical perspective of India's Science and Technology Policy)

3 S&T infrastructure and management of development and allocations of Developmental Plan funds to involve S&T and hence management of S&T spills over to sectors/ministries for whom S&T is not the core function

4 Evolution of sectoral policies (e.g. Human resource, health, environment, emerging technologies etc)

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-2-4407**			
Course Title	**Principle of Economics**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Core**			

Course Description:

Objective: The course is designed to expose the students to the basic principle of economics. The emphasis will be on thinking like an economists and the course will illustrate how economic concepts can be applied to real-life situations

Topics

1. Exploring the Subject matter of Economics

a. Why study Economics

b. How & for whom to produce & how to distribute

c. Basic competitive model

d. Gains from trade, comparative advantage

e. Revision of mathematical tools for studying economics

2. Supply and Demand: how markets works, Markets and Welfare

a. Demand & supply schedule and derivation of market demand and supply

b. Role of price in resource allocation

c. Concept of elasticity and its application

d. Consumer and producer surplus

e. Taxes and their efficiency costs

3. Introduction to Macroeconomics and National Income accounting

a. Basic issues studied in macroeconomics

b. Measurement of gross domestic product

c. Income, expenditure and the circular flow

d. Real versus nominal GDP

e. Price indices

f. Simple Keynesian model

g. Elements of oney and inlfation

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-2-4408**			
Course Title	**Social Studies of Science: An Introduction**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Core**			

Course Description:

Course overview :
This course deals with the social dimensions of science and technology.The efforts will be to introduce students to the approaches and theoretical strands in the field of science and technology studies -nature of science; the development/ construction of scientific facts; the social issues that arise in response to the advancement of science and technology. During the course an overview of the cross-disciplinary fields of sciencestudies such as psychology, philosophy and sociology of science will be drawn. The course as a part of Science, Technology and Innovation Studies (STIS) will discuss its emergence, its historical developments in various disciplines, such as, sociology, psychology.This course has the primary objective to make students familiar to the various concepts and theories related to the social studies of science rather than comprehensive accounts. This will be an interactive course with lots of discussion and explore the following topics:
I) Introduction
•
An introduction to science and technology studies
• History, emergence and development of the social studies of science
• Sub-disciplines of STS: Relationship among STS disciplines/ Meta-sciences
II) Major STS disciplines1
• Philosophy of Science - important issues and debates in philosophy of science; concepts associated with the philosophy of science
• Sociology of Science -Perspectives andTheoretical contributions in Sociology of Science (such as Bacon, Max Weber, Karl Mannheim, Robert Merton, Thomas Kuhn);Science as Culture and Practice;Social Stratification in Science;Scientific Controversies,Public Understanding of Science
• Psychology of Science -Introduction; Historical Issues and emergence of Psychology of science; Sub-disciplines/ fields dealing with psychological issues and social processes within scientific institutions; Psychology of Scientists; The Psychology of scientific behaviors and practices, such as Scientific Reasoning: Explanation, Confirmation Bias, misconductsin science and technology; Applied Psychologies of Science, such as The Psychology of Technological Invention.
• III) Special Topics on STS issues
Scientific Institutions/Organizations
Scientists in laboratories (Laboratory studies of Science)
Empirical studies in the Indian context.
Creativity in Science
Performance and Productivity in Science
Reward system and stratification in science
Gender and Science
Changing structure of science as a social institution in the contemporary period

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-2-4401**			
Course Title	**Trade and Technology**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Elective**			

Course Description:

Objective:
This course plans to make students aware of the theories and polices that has led to the globalization of the world economy. The course has three main components namely, international trade, foreign direct investment and international technology transfer. The emphasis on each component is to analyze the channels that are the driving force behind globalization of an economy

Topics & Subtopics:

1. International Trade
- The underlying causes of foreign trade
- Brief review of trade theories and trade policies
- Trade restriction and its instruments
- The roles of trade in fostering economic development
- Foreign trade and trade policies in India
- Rationale of the changes in policies since independence
- Key emerging issues

2. Foreign Direct investment
- Why do firms internationalize
- Reasons for international factor movement
- Brief review theories of FDI
- Potential benefits and costs of FDI for a host country
- The roles of FDI in economic development
- FDI inflows in India and the policy frame
- Characteristics of FDI in flows in India

3. International technology transfer
- Types of technology and knowledge transfer
- General channels for technology transfer and their influences on production
- Brief review approaches of international technology transfer
- International operation of national firms (transferability of comparative and competitive advantage)
- Conditions of host and home countries for technology transfer
- Theoretical implication of international technology transfer
- Technology transfer in India
- Technology spillover & Intellectual property right protection in India
- Technology development in India

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-2-4402**			
Course Title	**Enterprise Development through Value Chains Analysis**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Elective**			

Course Description:

Objective:
To train development professionals in order to increase the impact, scale and sustainability of initiatives that help small enterprises (SEs) grow, create jobs and reduce poverty. Value Chain Analysis enables us to understand competitive challenges and to identify vertical coordination mechanisms. Value Chain Development aims to improve access to markets and increase productive efficiency, ensuring that all actors including the resource-poor, benefit from these value chains.
Topics & Subtopics:
1. Value Chains: Introduction
• Introducing the value chain approach
• Identify and scan sub sectors
• Develop and apply selection criteria
• Developing maps to visualise the analyses
• Determine and measure dimensions of interest
2. Analysis of value Chains
• Undertaking economic analyses of value chains
• Define critical success factors for value chains and actors
• Upgrade strategic options and combinations
• Development models and accompanying roles of stakeholders
• Guest speaker: practices from the field
3. Application of Value Chains
• Facilitate value chain development process
• Financial instruments the financial institutions
• Applying tools in your real life case
• Applying tools in real life case
• Presenting and discussing the results of the real life case
• Planning next step in developing value chains
4. Value Chain Examples from Field
• Analysis of own value chain – which costs are related to every single activity
• Analysis of customers value chains – how does our product fit into their value chain
• Identification of potential cost advantages in comparison with competitors
• Identification of potential value added for the customer – how can our product add value to the customers value chain (e.g. lower costs or higher performance) – where does the customer see such potential

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-3-4401**			
Course Title	**Intellectual Property Rights in the Context of Research, Innovation and Development**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Elective**			

Course Description:

Objective:
The students would be able to learn the nuances of various forms of Intellectual property and their effectiveness in protecting various forms of creativity. They will be exposed to intellectual property innovation and development nexus and conflicts of interest that emerge and how IPR management can be undertaken effectively.
Topics and Subtopics:
1. Knowledge, Innovation and Intellectual Property Rights: An Introduction
2. Evolution of IP Statutes – Origin and Internationalisation
3. Contemporary IP Statues: Unification of IP rights
4. IPR and New Technologies
5. IPR in India
6. Debates on IPR and Development

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-3-4402**			
Course Title	**Global Warming: History, Trends and Politic**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Elective**			

Course Description:

Global warming is one of the most engaging issues among environmentalists, scientists, policy planners, statesmen and civil society lobbyists across the world. The problem is as real as it is contentious. The projected consequences are equally alarming yet contentious. The envisaged strategies are no less disagreeable among developed and developing countries of the world.

The debate on climate change/ global warming has arrived at some broad consensuses. It is now more less conceded that (i) the global temperature has been on the rise in a progressive manner since the onset of industrial revolution (mid-19th century), (ii) there is a corresponding increase in GHGs as well since that time, (iii) most of the increase in the GHGs is man-made, caused by excessive use of fossil fuels - `dirty fuels from the hell' - and massive deforestation, (iv) at this rate of temperature increase, global life cycle will be completely destabilized by the end of the century.

Given the enormity of the crisis world leaders are seriously engaged in minimizing the release of man-made GHGs since the last couple of decades. However, despite the well-meaning intentions, international negotiations on the issue of mitigating GHGs, and more especially CO2, have run into the most contentious issue of historical responsibility on the part of developed world, and right to progress of the developing and under-developed countries. The journey from Kyoto (1997) to Doha (2012) has been a story of hope and despair.

With the lobbyists failing the mark, our hope rests on energy innovation, especially the renewable energy. However, new energy options needs to be critically examined in terms of cost, risks and comparative advantages.

The course will cover the following issues:

- Global warming: Real or Myth
- History, trends and projections of the warming of the planet
- Green House Gases (GHGs) : sources, trends and projections
- Impact Assessment – global and national
- Energy innovation: history, trends and future of green energy
- International negotiations–Kyoto (1997) and beyond

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-3-4403**			
Course Title	**Resource Planning & Policy (RPP)**			
Credit Distribution (L-T-P-C)	1	1	1	**1**
Core/Elective	**Elective**			

Course Description:

Objective:
The course will have an inquiry driven approach to examine the formulation of resource planning and policy based on theoretical exposition in the domain of macroeconomics particularly the post Keynesian school in economics by addressing the core issues such as, the strength of communities and nations is primarily determined by two aspects, viz.

• the availability of resources they have and,(ii) the capacity they have to utilize these in a rational manner.
• Those communities and nations have been less developed which could not sufficiently develop the capability to exploit their resources rationally and also those whose resources are over exploited by others.
• For developing capabilities, making use of resources and evolving institutional framework for enough utilization of their resources, importance of planning & policy making of resources become much important.

Topics and Subtopics:

1. Historical Context of Resources Evaluation
2. Regional Development
3. Resources Utilization in Marginal Areas/stressed lands
4. Resources &Environment
5. Natural & Human Resources Interaction
6. Resources & Poverty Alleviation
7. Geospatial technology applications in resources assessment and planning

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-3-4404**			
Course Title	**Introduction to Public Health Policy**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Elective**			

Course Description:

Objective of the course:To provide an overview of the nature & process of making of policy for public health within the various domains of public health to gain a basic understanding of the policy process and health politics.The course provides an introduction to theoretical framework and motivations for developing a public health policy, intervention of various actors and stakeholders, the influence of political, bureaucratic, international, academic and social environments in which policy decisions are made, their impact on public health, and the key dimensions of the analysis of the effects of public health policies.
The course is designed for students,
• To understand Indian public health system to monitor & improve the public's health from policy perspective.
• To develop skills in critical thinking about public health issues from a policy perspective (identifying different types of policy interventions and their rationale or justifications).
• To develop skills for identifying, collecting, analyzing and communicating policy-related information about public health.
• To create awareness on the current key policy issues in public health and be able to articulate a testimony in support of a policy position.
Topics & Subtopics:
1. Concepts of Public Health
2. Indian public Health system and health systems in other countries
3. Concepts of Public Health Policy (PHP)- what policy is; who are the policymakers; who gets affected by PHP; who advocates it & how it impacts developing & implementing PHP; the major influences (Cultural, economic, & social factors) that determine what policy gets formulated and implemented. This will cover the following subtopics.
Theoretical framework & motivations for developing PHP
- The role of various actors (Political, bureaucratic, international, academic, civil society)
Social environments in which policy decisions are made & its impact on PH
key dimensions of the analysis of the effects of public health policies
Varying policy decisions that lead to different actions by government
4. Introduction to Evidence based policy/national PHP
5. Policy instruments of Public health (assessment studies, capacity building, epidemiological evidences, law, CBA, governance).
6. Other Policies of nation that shape or influence public health policy [Pharmaceutical industrial policy, health policy, drug policy, pricing policy, patent policy, immunization policy, nutrition policy, vaccine policy, environment policy, Water policy, sanitation policy, etc.]
7. Regulation in policies of public Health:IPR & Public health. Regulations in different sections of public health such as new drug, marketing, advertising and investment approvals, safety evaluation studies etc., affect IPR in public health, policies on preventive medicine, environmental and occupational health.
8. Public health and governance

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-3-4405**			
Course Title	**Science, Technology and Innovation Strategy**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Elective**			

Course Description:

Objective
The objective of the course is to familiarize students with various dynamics of technological innovation an element of organization and national competitiveness. At the end of the course students shall be able to understand various aspects of developing a technology strategy at micro and macro level.
Course Contents
Definitions, concept of technology, technology as a resource, scope of technology management, role of technology in competitiveness enhancement, path from invention to commercialization-case studies; definition and concept of innovation, types of innovations, challenges for innovation, market potential of a technological innovation, life span of a technology: innovation-pilot production- diffusionsubstitution; technology transfer models, dimensions, routes and features of technology transfer, technology licensing, patent analysis; factors determining appropriate technology, formulating technology policy-at organizational and national level, role of socio-economic goals in determining technology policy; nature of technology change- incremental and radical innovations, technological revolutions; technology forecasting and innovation, approaches to technology forecasting, methods of technology forecasting and their comparison; difference in technology generation and development, stages and elements involved in technology generation process; concept of technology absorption, constraints in technology absorption, Indian experience in technology absorption, Government efforts in import, absorption, development and diffusion of technologies; overview of trade and industrial policy, incentives and support mechanisms, S & T policies of select developed countries; financial aspects in establishing a technology based enterpriseventure capital, working capital, capital markets; analyzing and preparing case studies.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-3-4406**			
Course Title	**An Introduction to Probability and Statistics**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Elective**			

Course Description:

Chapter 1: Introduction to statistics
Relevance of statistics, mathematical models deterministic and
Stochastic; random variables; populations and samples; parameters
and statistics.
Chapter 2: Review of basic concepts
Measurement theory, levels of measurement; numerical measures
of data; graphical presentation of data; Chebyshev's theorem;
Measurement uncertainty.
Chapter 3: Probability theory
• Probability concepts
• axioms of probability; probability
• Distribution functions and their applications - discrete and continuous distributions.
Chapter 4: Theoretical distributions
• Probability mass and probability density function
• Characteristics of theoretical distributions
• Binomial Distribution and negative binomial distribution
• Poisson's distribution
• Normal Distribution
o General features of normal distributions
o Probability calculations with normal distributions
o Normal distribution tables
o Assessing Normality
o Normal Probability Plot Interpretation
Chapter 5:Data sampling
• Methods for selecting sampling locations and times
• sampling theory
• Sample size determination for different sampling designs.
Chapter 6:Tests of hypothesis
• Basic understanding of hypothesis
• Hypothesis testing parametric and non-parametric tests.
Suggested Literature:
1. Fundamentals of Statistics, Gun Gupta, Dasgupta, The world Press
2. Statistics for Business, Robert Stine, Pearson
3. Introduction to Basic Statistics, Pat Hammett, University of Michigan
4. Probability & Statistics for Engineers &; Scientist, Ronald E. Walpole, Pearson's
Education International
5. Open literature from Internet

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-3-4407**			
Course Title	**Foundations of Mathematics**			
Credit Distribution (L-T-P-C)	1	0	0	**1**
Core/Elective	**Elective**			

Course Description:

This course is an introduction to the basic concepts and applications of mathematics necessary for graduate-level training and preparation for Ph.D. The materials learned in this course will be useful for understanding theoretical and experimental concepts and models in economics, sociology, policy research and analysis, biology, epidemiology, demography, environmental and atmospheric science, and many other areas and disciplines.

Course Description

This course introduces students to the basic concepts and applications of mathematics. Students learn how to identify key ideas of mathematics, to detect and generate workable structures using them, and to model system processes in different disciplines. The applications of the mathematical knowledge are in fields as diverse as sociology, biology, growth and diffusion processes in epidemiology, economics and statistics, engineering, telecommunications and messaging, etc.

Learning Objectives

The main learning objective of this course is to enable students to think analytically in a planned, informed and efficient manner. This goal involves the following tasks:

• Formalize different types of mathematical concepts
• Plan and execute applications of concepts in physical problems
• Interpret and synthesize the meaning of the results with respect to a specific question, goal, or task

Topics Covered

Calculus

• Numbers
o Integers
o Rational and irrational numbers
o Real number continuum
o Associated mathematical operations on numbers
• Functions, limits, and continuity
o Definition of single variable and multivariable functions
o Limits of functions
o Continuous and discontinuous functions
• Derivatives and integrals
o Ordinary derivatives of common functions
o Derivatives as rates
o Partial derivatives
o Indefinite integrals of ordinary functions
o Definite integrals as the limit of a sum
o Definite integrals as areas
• Differential equations and dynamical systems
o Introduction to ordinary differential equations
o Dynamical systems and their behavior in time
• Optimization and constraints
o Understanding optimization problems
o Constraints
o Optimization subject to constraints
• Algebra and trigonometry
o Binomial theorem

o Permutations and combinations
o Basic trigonometric functions
o Logarithms
Linear algebra
• Set theory
o Elements of sets and operations on them
• Vectors
o Concept of vectors
o Operations on vectors (addition; subtraction; dot products; compositions; etc.)
• Matrices
o Matrices and determinants
o Matrix operations (addition; subtraction; products; inversion; etc.)
o Eigenvalues and eigenvectors
Course Prerequisites
This course is designed to benefit a broad representation of students from different disciplines. No specific technical or numerical background is required. College-level algebra is required. The emphasis of the course will be on the applications of mathematics
Course Structure
This course is based on lecture notes and weekly assignments. There is one in-class final exam

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-4-0001**			
Course Title	**Project Proposal**			
Credit Distribution (L-T-P-C)	0	0	4	**2**
Core/Elective	**Core**			

Course Description:

Objective:
The course will have an inquiry driven approach to examine the formulation of resource planning and policy based on theoretical exposition in the domain of macroeconomics particularly the post Keynesian school in economics by addressing the core issues such as, the strength of communities and nations is primarily determined by two aspects, viz.

• the availability of resources they have and,(ii) the capacity they have to utilize these in a rational manner.
• Those communities and nations have been less developed which could not sufficiently develop the capability to exploit their resources rationally and also those whose resources are over exploited by others.
• For developing capabilities, making use of resources and evolving institutional framework for enough utilization of their resources, importance of planning & policy making of resources become much important.

Topics and Subtopics:

1. Historical Context of Resources Evaluation
2. Regional Development
3. Resources Utilization in Marginal Areas/stressed lands
4. Resources &Environment
5. Natural & Human Resources Interaction
6. Resources & Poverty Alleviation
7. Geospatial technology applications in resources assessment and planning

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-4-0002**			
Course Title	**Review Article**			
Credit Distribution (L-T-P-C)	0	0	4	**2**
Core/Elective	**Core**			

Course Description:

Preparation of one review article on specific research area of the student.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-NISTADS, New Delhi**			
Course Nomenclature	**MIS-NISTADS-4-0003**			
Course Title	**CSIR-800 Societal Program**			
Credit Distribution (L-T-P-C)	0	0	8	**4**
Core/Elective	**Core**			

Course Description:

The students have to undertake a project in rural area for 6-8 weeks in line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S & T inventions. The theme for the project may be chosen from CSIR-800 document and as per expertise available at individual laboratory. Students will choose the topics in consultation with Doctoral Advisory Committee (DAC).

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune**			
Course Nomenclature	**MIS-URDIP-1-0001**			
Course Title	**Research Methodology**			
Credit Distribution (L-T-P-C)	1	1	0	**2**
Core/Elective	**Core**			

Course Description:

Course description: Introduction, Research terminology and scientific methods, different types and styles of research, role of serendipity, creativity and innovation, Scientific and critical reasoning skills, art of reading and understanding scientific papers, literature survey. Measurements in research - primary and secondary data. Quantitative methods and data analysis, Qualitative analysis, Communicating research results. Designing and implementing a research project. Ethics in research, Plagiarism, Case studies. Laboratory safety issues – lab, workshop, electrical, health & fire safety, safe disposal of hazardous materials.

Role & importance of communication, Effective oral and written communication. Technical report writing, Technical/R&D proposals, Research paper writing, Dissertation/Thesis writing, Letter writing and official correspondence. Oral communication in meetings, seminars, group discussions; Use of modern aids; Making technical presentations.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune**			
Course Nomenclature	**MIS-URDIP-2-4801**			
Course Title	**Advanced Self Study**			
Credit Distribution (L-T-P-C)	0	2	4	**4**
Core/Elective	**Core**			

Course Description:

Aims to train the student on learning, on one's own, topics that are not formally taught in a course. This would involve primarily three components - collection of relevant literature on a chosen topic, organization of relevant material into a written report based on candidate's own critical understanding and finally presentation of the findings in front of wide audience in the form of a seminar. Thus communication skills are also expected to be honed up.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune**			
Course Nomenclature	**MIS-URDIP-3-4801**			
Course Title	**Bioinformatics**			
Credit Distribution (L-T-P-C)	2	0	1	**3**
Core/Elective	**Elective**			

Course Description:

What is bioinformatics, Basic concepts, Sequence, structure and function, Bioinformatics databases, Type of databases, Secondary nucleotide sequence databases, Sequence motif databases, Protein structure databases, Other relevant databases such as KEGG, DockGround, Sequence alignment and database searching, scoring matrix, Dynamic programming, Heuristic methods, Statistics of sequence alignment score, Multiple sequence alignment, Hidden Markov Models.

Protein structure alignments, structure superposition, RMSD, Different structure alignment algorithms, Protein secondary structure predictions, Protein tertiary structure modelling, Protein folding and dynamic simulation, Comparative modelling, Threading, Combined modelling approaches, Protein quaternary structure modelling.

Rapid development programming languages (Python, Perl), relational databases (SQL), Java, exploratory data analysis in R.

Techniques for designing efficient algorithms and basic mathematical methods for analyzing their performance. Paradigms for algorithm design: divide-and-conquer, greedy methods, graph search techniques, dynamic programming. Protein-protein docking algorithms, Semi-flexible docking: Side-chain refinement, Protein-ligand docking algorithms, Multiple-threading algorithms.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune**			
Course Nomenclature	**MIS-URDIP-3-4802**			
Course Title	**Cheminformatics**			
Credit Distribution (L-T-P-C)	2	0	1	**3**
Core/Elective	**Elective**			

Course Description:

Introduction to cheminformatics: aims, scope- Role of Cheminformatics in pharmaceutical / chemical research- Representation and manipulation of 1D, 2D and 3D molecular structures.-Molecular file formats (SMILES, WLN, SDF, MOL), Molecular patterns- SMARTS, SMIRKS-Molecular descriptors - Calculation of descriptors reflecting physical and chemical properties of the molecules, including fingerprints and methods used for evaluation of molecular similarity and for selection of structurally diverse and representative subsets Properties - Calculation of physico-chemical properties such as solubility and partition coefficients, pharmacological properties such as absorption and distribution, and global properties such as oral bioavailability and "drug-likeness" data analysis- Molecular similarity and molecular diversity analysis. Similarity index- Molecular Database Screening: (Lipinski Rule: Drug/Lead like molecules) Clustering and Statistical analysis for Molecular Informatics (PLS, PCA, PCR, kNN, ANN, Correlation and regression analysis) - Modeling of small molecules using molecular mechanics and quantum mechanics methods. Quantitative structure activity relationship (QSAR), Quantitative structural

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property relationship (QSPARs), Quantitative structural Toxicity Relationship (QSTR), Pharmacophore modeling- In silico virtual screening- Docking studies.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune**			
Course Nomenclature	**MIS-URDIP-3-4803**			
Course Title	**IP Management**			
Credit Distribution (L-T-P-C)	2	1	0	**3**
Core/Elective	**Elective**			

Course Description:

Historical overview of IP systems
The patent power - What is a patent – Types of patents – Why patent? – How does the patent system work? Types of applications –Common myths about patents (duration, ownership, freedom to practice, secrecy, global patent, geographical boundaries) – Infringement – Damage awards - Industry structure and importance of patent – Leveraging patents as financial assets – Perils of ignoring patents – IP savvy organizations
Requirement of a patent – Criteria for patenting – subject matter, novelty, non obviousness, utility
– Enablement, Best mode, Definiteness- Unity of inventions- Inventorship - Statutes – Interpretation – Infringement-Case studies
Abstract – Specification – Written description – Claims – Independent and dependent claims – Swiss claims – Length of a document – Claim drafting with file Estoppel in mind – Capturing invention
Should a patent be filed? – Where to file – Criteria – When to file? - Timing and filing – Foreign filings – The PCT route – Drafting the application – USPTO procedures – Manipulating patent filing and prosecution process – Maintaining secrecy for longer - Fighting competition – Importance of record keeping.
Goals of patent strategy – types of strategies – Shield and sword patents – Protecting markets, Company and future – Protecting single invention – Multiple inventions – Bracketing, clustering and fencing - Strategy for existing products – Patent investment strategies for commercializing technology - Aligning patent strategy with business strategy – Business driven patenting strategy extending the life of invention – Transferring IP assets to business assets – Invention, product and market considerations – Market economies and technology density considerations – Organizing patent portfolio – Enhancing patent quality – Patent cost management – Benchmarking patent strategy against competition – Patent strategy for long term growth – Patent strategy for building corporate assets and exploiting the same – Case studies
Conventional flow path for product development – Gaps analysis for R&D planning – New model
– From pure research to commercial development – Market pull vs. research push
Role of IP in M&A decisions –– IP due diligence for M&A – Negotiating value – Case studies Approaches to exploiting IP –When licensing is the preferred option – Rationale for licensing – Objectives of licensing – Carrot and stick licensing, - Licensing decision – factors governing licensing and financial compensation – Approaches to IP valuations – Sharing profits – Cost based valuations – Market based valuations- Industry standards -Researching the markets and targets – Scope of licensing – Exclusive/ non exclusive, territories, duration, non competitive clauses – sublicensing – improvements – cross licensing, - Preparing for negotiations – Steps and processes for negotiation – Responsibilities of the licensor and licensee – Draft agreements
– Typical drafts – Licensing as a business strategy in chemical industry – Licensing practices at leading companies - Trends in IP and licensing management – Case studies
Levels of IP exploitation in organization – moving up the value chain - organization – From filing to transacting – Transformation at Xerox, Dow Chemicals, P&G.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune**			
Course Nomenclature	**MIS-URDIP-3-4804**			
Course Title	**Patinformatics**			
Credit Distribution (L-T-P-C)	2	0	1	**3**
Core/Elective	**Elective**			

Course Description:

Introduction to IPR, Understanding Patents and Patent Legislation – Requirements of Patentability, Patent Treaties, Reading a patent -– Anatomy of a patent and implications - Dissecting the parts – Independent and dependent claims – Claim interpretation – Evaluating strengths and weaknesses of a patent
– The file history and implications
Introduction to Patinformatics – Patent Families, Patent Citations- Relationships and Trend Analysis- Patent Intelligence – Patent Searching-Types of searches- Patentability – Validity – Infringement – Clearance (FTO)- State of the art – Landscape search –Search methodologies – Key word searches-Patent classification systems, Introduction to patent databases (Free and Paid), Searching on various patent databases, Patent analysis and mapping, Patent analysis and mapping tools, Patent information for strategic planning and technology management, Patent indicators and patent statistics for policy making, Planning R&D investments and measuring R&D performance
Hands-on – Patent searching, Patent search and analysis reports for various end uses

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune**			
Course Nomenclature	**MIS-URDIP-3-4805**			
Course Title	**R&D Management**			
Credit Distribution (L-T-P-C)	2	1	0	**3**
Core/Elective	**Elective**			

Course Description:

Conceptual framework of R&D management – Origins of industrial R&D – The industrial R&D process - Changing role of R&D in industry - Role of R&D in technological innovation - Implications for R&D strategy – Formulating R&D strategy – Evolution of corporate R&D – Centralized vs decentralized R&D – Organizational structure for R&D - Input and output oriented structures – Critical activities of R&D function - Role of leadership - Components of R&D organization – Make vs buy decision - R&D project management - R&D project portfolio - Resource allocation for R&D – Managing value and risk in R&D portfolio Aligning R&D portfolio with business strategy - Planning directed basic research - Globalization of R&D- Implications for corporate R&D - Coordinating multi locational R&D Location strategies – Global R&D centres in India - From first to fourth generation R&D - Project selection and evaluation - Evaluation of R&D performance – R&D performance metrics – R&D performance effectiveness and impact - Decision support systems for R&D project management – Terminating R&D projects - Post project evaluation and learning - Trends in R&D management – Open Innovation- Working with national innovation systems – Directed basic research with universities - Managing R&D collaborations – Issues in value based R&D Case studies in R&D management - 3M, DuPont, GE, P&G , Merck.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune**			
Course Nomenclature	**MIS-URDIP-3-4806**			
Course Title	**Technology Management**			
Credit Distribution (L-T-P-C)	2	1	0	**3**
Core/Elective	**Elective**			

Course Description:

Concept and framework of technology management - Strategic role and scope of technology management – Technology life cycles and flow processes- S curves in technological progress – Technology push vs. market pull – Product life cycles – Technology diffusion

The technology environment – Industry structure – Organizational structure – resources – Competitive advantage at firm and national level

Product, technology and business strategy – Aligning strategies

The positioning approach – Resource based approach – Rationalist and incrementalist approach Technology selection –Timing – Acquisition or development – Make vs. buy decision – Types of technology strategies

Models of technology growth and diffusion – Forecasting techniques and tools – Managing forecasting process – case studies from industries – Technology monitoring – Trend analysis techniques and tools – Simulation and scenario building – Economic forecasting and analysis – Forecasting directions and changes – Forecasting technological discontinuities and change

Mapping technological environment – competitor activities –assessing technological positions - Technology analysis – Technology base of the firm - Technology planning and business strategy - - The planning process – Case studies from chemical industries

Profit sharing – Cost basis – Market basis – Economic assessment- DCF analysis to estimate present value

Modalities of acquisition – Joint ventures – outsourcing - Licensing – Discipline of acquisition – Role of management – Factors influencing managerial decision – selecting partners – Case studies

The licensing decision – Licensing strategies – Due diligence prior to licensing - Licensing agreements – Negotiating and drafting – Model agreement- Post licensing activities - Licensing from universities – case studies

Technology transfer, Technology management case studies, developing technology managers.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune**			
Course Nomenclature	**MIS-URDIP-4-0001**			
Course Title	**Project proposal writing**			
Credit Distribution (L-T-P-C)	0	0	4	**2**
Core/Elective	**Core**			

Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune**			
Course Nomenclature	**MIS-URDIP-4-0002**			
Course Title	**Review Article**			
Credit Distribution (L-T-P-C)	0	0	4	**2**
Core/Elective	**Core**			

Course Description:

Preparation of one review article on specific research area of the student.

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune**			
Course Nomenclature	**MIS-URDIP-4-0003**			
Course Title	**CSIR-800 Societal Program**			
Credit Distribution (L-T-P-C)	0	0	8	**4**
Core/Elective	**Core**			

Course Description:

The students have to undertake a project in rural area for 6-8 weeks in line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S & T inventions.
Alternatively students admitted at URDIP will be permitted to undertake one of following activities:
Create a database of patents which have come into public domain (Expired Patents, Non-jurisdiction Patents, Patents not granted, abandoned applications and Invalid Patents). This database then can be used to Support CSIR-800 programme to solve societal problems quickly. Similar database can also be used to support MSME sector as most of them use old techniques of production and outdated machinery and equipment.
The priority will be the areas already identified and referred by the Coordinator of CSIR-800 programme or the laboratories involved in CSIR-800 programme. Based on the identified areas and needs, student will build a problem/subject specific database and share it with scientists/technologists working on the particular project.
Alternatively, problem will be chosen from one of the clusters identified under the CSIR Cluster Innovation programme.
An opportunity assessment study or a techno-economic survey that will benefit rural economy.
Students will choose the topics in consultation with Doctoral Advisory Committee (DAC).

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4803**			
Course Title	**Introduction to IPR and Patents and Patent Legislation**			
Credit Distribution (L-T-P-C)	2	4	0	**6**
Core/Elective				

Course Description:

Introduction to IPR, Understanding the Patents, Reading a Patent, Patent Legislation – Requirements of Patentability, Patent Infringement

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4804**			
Course Title	**International Framework**			
Credit Distribution (L-T-P-C)	2	0	0	**2**
Core/Elective	**Core**			

Course Description:

Patent Treaties, American and European Patent System, Hatch Waxman Act and the Medicare Amendment

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4805**			
Course Title	**Patinformatics and Basics of Patent Searching**			
Credit Distribution (L-T-P-C)	2	0	0	**2**
Core/Elective	**Core**			

Course Description:

Introduction to Patinformatics, Patinformatics – Types of Searches, Understanding Patent Search Fields, Patent Citations and Legal Status, Patent Families, Patent Classification Systems, Introduction to Patent Databases, Understanding Derwent and Manual Codes

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4806**			
Course Title	**Searching on Patent Databases**			
Credit Distribution (L-T-P-C)	2	0	0	**2**
Core/Elective	**Core**			

Course Description:

STN, Derwent, Thomson Innovation, PatBase, QPat, STN – Basic Search, CAPLUS and Registry, Structure Searching

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4807**			
Course Title	**Understanding Database Features**			
Credit Distribution (L-T-P-C)	2	4	0	**6**
Core/Elective	**Core**			

Course Description:

Introduction to Thomson Innovation, Thomson Innovation Search Techniques and Advanced Features, Understanding Dialog, Dialog Search Basics, Advanced Searching Using Dialog, Comparative Assessment of Various Patent Databases and their Advantages

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4808**			
Course Title	**Advanced Patent Searching**			
Credit Distribution (L-T-P-C)	2	0	0	**2**
Core/Elective	**Core**			

Course Description:

Advanced Searches Using CAPLUS and Registry, Searching for Markush Structures on Marpat, Advanced Structure Searching Techniques, Searching for Patent Family and Legal Status Information on STN

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4809**			
Course Title	**Information searching in various Domains**			
Credit Distribution (L-T-P-C)	2	0	0	**2**
Core/Elective	**Core**			

Course Description:

Searching for Chemical, Pharmaceutical and Engineering Information on STN, Advanced Patent and Scientific Literature Search Techniques

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4810**			
Course Title	**Patent Analytics & Mapping and its Application**			
Credit Distribution (L-T-P-C)	2	0	0	**2**
Core/Elective	**Core**			

Course Description:

Introduction to Patent Analysis and Mapping, Patent Analysis Tools, Understanding: Aureka, Aurigin Systems, Vantage Point, Metrics System, Thomson Innovation, Clear Forest, Smart Charts, Technology Scenario Analysis, Technology Movement Assessment, Research and Business Planning, Freedom To Operate, New Product Development Studies, Patentability And Validity Studies, Using The Patent Search And Analysis Tools

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4811**			
Course Title	**Patent information for Technology Planning and Management**			
Credit Distribution (L-T-P-C)	2	4	0	**6**
Core/Elective	**Core**			

Course Description:

Basics of technology strategy - technology strategy and competitive advantage - aligning technology strategy with business strategy- positioning and resource based strategies-technology strategies of firms – Patinformatics for technology mapping, .intelligence and forecasting - competitor analysis - technology planning techniques- -case studies in technology strategies of firms – Patinformatics for IP based technological alliances – M&A decisions – target identification for complementarity - IP driven acquisitions

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4812**			
Course Title	**Patinformatics for Patent Valuation**			
Credit Distribution (L-T-P-C)	2	0	0	**2**
Core/Elective	**Core**			

Course Description:

Defining patent value - patent value indicators - Determinants of patent value in academic and industrial environment - issues in measuring the value of patents - Analyzing patents and the science base of technologies - factors influencing patent value– Patent quality and profitability - Evaluation of quality and correlation with H index

Commercial valuation of patents – valuation checklist - twenty steps in pricing -– modeling of the value of patent - analysing patent ratings - citations as indicators of economic value - impact of court decisions in damage settlements – valuation using income - maximum profits and real options approach – valuation during licensing - retrospective valuations of patents - value-chain patent strategy to enhance commercial value of patents

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4813**			
Course Title	**Patinformatics for R&D planning, Strategic Patenting and Performance Benchmarking**			
Credit Distribution (L-T-P-C)	2	0	0	**2**
Core/Elective	**Core**			

Course Description:

Nature of R&D – Motivations of basic vs. applied research - Evolution of R&D management-First to fourth generation R&D- Business driven R&D- Globalization of R&D- implications for corporate R&D - IP driven R&D - Patent mining for gap analysis and scoping R&D projects – strategic patenting – IP audit of R&D projects vis a vis competition for strategic R&D planning

Faculty	**Mathematical & Information Sciences**			
Lab Name	**CSIR-URDIP, Pune-PGDPI**			
Course Nomenclature	**MIS-URDIP-2-4814**			
Course Title	**Patinformatics for Patent Strategy and Portfolio Management**			
Credit Distribution (L-T-P-C)	2	4	0	**6**
Core/Elective	**Core**			

Course Description:

Value of patents to technology driven companies - innovation strategy and the patenting behavior of firms - patent strategy of firms - Choosing a patent strategy-business decisions in patenting- defensive vs. offensive strategy - patent portfolio attributes and value of the company's IP portfolio - benchmarking portfolios using the patent asset index – influence of strategic patenting on companies' patent portfolios – Comparative evaluation of patent portfolios of firms in an industry- portfolio analysis to check integration between patent strategy and business strategy– portfolio management at commercial firms