COURSE DESCRIPTION FOR AUG-DEC 2015

(1) **Course Name:** Introduction to Feedback Control
Course code: EE-5XX
Credits: 3-0-0-3 (Lectures-Assignments-Practical-Total)
Prerequisites: UG Control theory
Intended for: UG/MS
Elective/Core: Elective
Semester: Odd/Even
Faculty: Dr. Subashish Datta

Preamble: This course is designed for senior undergraduate and first-year graduate students, assuming that they are already introduced to the first level UG control theory course. This courseprovides an in-depth knowledge on analysis of SISO as well as MIMO systems. In addition, emphasis on modern control design techniques will given, which leads to a more practical and hands-on approach to the subject. Several fundamental concepts, such as poles, zeros and their directions, performance limitations due to RHP-zeros and input delay will be introduced in the course. Stability analysis via Nyquist plot will be discussed for both SISO and MIMO systems. Furthermore, robust stability and advanced controller design techniques will be discussed.

Course Outline: The course is divided in five modules. In the first module, mathematical preliminaries, such as matrix norms, signal and system norms, singular value decomposition will be introduced. Second and third module cover the analysis of linear time invariant systems and the interconnection of plant and controller. Fourth module introduces the concept of uncertainty and robust stability of a system. In the last module students will learn several controller synthesis procedures for dynamic output feedback control, LQR and LQG control.

Modules:

1. *Mathematical Preliminaries: 4* lectures

Vector and matrix norms, Signal and system norms (2-norm and infinity norm), Singular value decomposition.

2. *System Analysis:* 10 lectures

System representation, sensitivity and complementary sensitivity function, concept of poles and zeros, pole and zero directions, controllability & observability, performance limitations.

3. *Feedback interconnection & Stability theory:* 5 lectures

Well-posedness of feedback loop, Internal stability of feedback system, Nyquist plot, Small gain theorem.

4. *Uncertainty and robustness*: 7 lectures

Uncertainty representation, robust stability and robust performance.

5. *Controller Synthesis*: 9 lectures

Stabilizing controllers, Introduction to $H2$ and $H\infty$ control (including LQR and LQG control).

Textbook

1. S. Skogestad and I. Postlethwaite, Multivariable Feedback Control: Analysis and Design, John Wiley & Sons, 2001. (second edition)

Suggested References

2. K. Zhou, J. C. Doyle and K. Glover*, Robust and Optimal Control*, Prentice-Hall, Englewood Cliffs, NJ, 1995.

3. O. H. Bosgra, H. Kwakernaak, and G. Meinsma, *Design Methods for Control Systems*, Notes for a course of the Dutch Institute of Systems and Control, Winter term 2000–2001.

(2) **Course Name :** CELLULAR FUEL AND CELLULAR COMMUNICATION
Course Number: BY 5xx
Credit: 3-0-0-3
Prerequisites: - IC 136 - Understanding Biology or Consent of Faculty member
Students intended for: B. Tech. 3rd and 4th year, MS/M.Tech., Ph.D.
Elective or Compulsory: Elective
Semester: Odd/Even
Faculty : Dr. Prosenjit Mondal

Course Objective: Major goal of is course is to introduce the concepts of cellular biochemistry and metabolism. Other goal of this course is for student's to understand the biological functions of the biomolecules. Also students will learn the significance of signaling and its impact in relation to human health. The format of the course is a combination of lectures and student presentations. In addition to this, few journal publications will also be discussed in order to help students understand some of the recent topics in this area.

Course Outline:

Module 1 [Fifteen Lectures]

C**ellular fate of nutrients metabolism**: Glucose metabolism; Glucose transporters, Glycolysis, TCA cycle, glycogen synthesis, gluconeogenesis, and glycogenolysis. Metabolism of amino acids and proteins, Metabolism of lipids; oxidation of fatty acids, ketone bodies and ketosis, de novo synthesis of fatty acids, Metabolism of nucleic acids; Biosynthesis and breakdown of purine and pyrimidine nucleotides, Salvage pathways.

Module 2 [Fifteen Lectures]

The cellular internet: The essential elements of cellular transduction mechanisms that allow signaling from the cell surface to the nucleus; reception, transduction and response. Types of signals: Endocrine, Paracrine, Neural, and Juxtacrine. Receptors and receptor trafficking, Types of Cell surface receptors: G-protein coupled receptors, Receptor tyrosine kinase receptors, Cytokine receptors and Non-tyrosine kinase receptors, Integrin receptors, Toll-like receptors, Ligand gated ion-channels receptors, Receptors with other enzymatic activities. Second messengers; Type of secondary molecules; diacylglycerol, phosphatidylinositols, cAMP, cGMP, IP3, and Ca2+. 2

Module 3 [Twelve Lectures]

Hormone and Endocrine system: Body's long distance regulator; Hormones, Local regulators, Neurotransmitters, Neurohormones, and Pheromones. Type of hormones, Major endocrine gland, and Hormone transport, Hormone receptors - cell surface and intracellular, Mechanisms of hormone action, Neuroendocrine interactions.

Text Book:

1. Molecular Biology of the Cell (5th edition) by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff , Keith Roberts , Peter Walter

2. Lehninger Principles of Biochemistry (6th edition) by David L. Nelson, Michael M. Cox

Reference Book

1. Campbell Biology (10th Edition) by Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson,

(3) Course Name: Biophysics and Protein Engineering
Course Number: BY502
Credit: 3-0-0-3
Prerequisites: - IC 136 - Understanding basic Biotechnology & its Applications or Consent of Faculty member
Students intended for: UG/PG
Elective or Compulsory: Elective
Semester: Odd/Even
Faculty: Dr. Rajnish Giri

Course Preamble: This course is a blend of modern discoveries and applications in protein sciences along with conventional protein science concepts, general biophysics and methods. Recent discoveries that some proteins without having structure in physiological buffer conditions are abundant in nature, constituting up to 40% of human proteome in part or full, lead to a new branch of Intrinsically Disordered Proteins (IDPs). IDPs are involved in cell signaling and responsible for a wide range of diseases. IDPs are also present in other domain of life and are responsible for many cellular functions. A combination of ordered and disordered protein knowledge will make a complete package for protein science understanding for students. By the end of this course, the students are expected to know how to apply Physics, Chemistry and Biology principles in order to understand the structure and the dynamics of biological systems, and which experimental approaches are best suited to extract the quantitative information.

Course Outline:

Module 1 [6 Lectures]

Course Introduction, what is biophysics? What will you learn? – A general outline of the course.

Outlook: what is the use of what you will learn here?

The hierarchy and order of protein structure: amino acids and peptide bonds; the secondary structure: α-helices, β-sheets, turns and loops; supersecondary structure – domains and motifs the tertiary and the quaternary structure. Hemoglobin and myoglobin as paradigm proteins, protein characteristics and structure-function relationships. Software and online/freeware tools for analyzing proteins e.g. Rasmol and PyMol. Homology modeling as exercise for structural elucidation of biological macromolecules.

Module 2 [6 Lectures]

Intrinsically Disordered Proteins: Sequence composition of IDPs, distribution of IDPs in nature and their physiological roles, intrinsically disordered regions, fuzzy complexes, designed linkers, folding and binding mechanisms of IDPs. Protein disorder in signaling and disease in human and plants.

Applications of IDPs or linkers in fusion proteins of clinical importance:. Chimeric Antigen Receptors as an example of multidomain fusion protein involving folded and unfolded polypeptide chains.

Module 3 [8 Lectures]

Thermodynamics: a brief introduction and thermodynamic principles. Gibbs free energy, thermochemistry and calorimetry. Protein folding theories and structural transitions in polypeptides.

Module 4 [15 Lectures]

Biophysical Methods: Absorption spectroscopy, UV/VIS spectroscopic analysis of biopolymers. Linear dichroism: transition dipole moments and the orientation of biomolecules. Circular Dichroism: the molecular origins of the rotational strength of molecules. Applications of polarized light interactions with chromophores in protein and DNA with case studies from literature.

Florescence spectroscopy: basic principles and instrumentation. Florescence of protein and DNA, florescence resonance energy transfer (FRET). Working principle and major application of other spectroscopic methods (FTIR, NMR, mass spectrometry and Ultrafast etc) for proteins.

Module 5 [16 Lectures]

Protein Engineering – Basic Principles and Rationale: Identification of putative enzymes in sequence databases, bioinformatic analysis. Enzymes, enzyme catalysis and kinetics, factors influencing the speed of enzymatic reaction. Enzyme applications, targets of protein engineering, protein engineering approaches, advantages and limitations. Rational design, comparative design, random methods; prediction of the structure of enzyme variant, evaluation of the effect of mutations on enzyme structure and function. Successful stories of application of protein engineering to improve enzyme catalytic efficiency, enzyme stability and folding. Therapeutic potentials of proteins with specific examples including insulin, anticoagulants, blood substitutes and vaccines. Sequence composition and heteromorphic pairs of proteins.

Text & Reference Books:

A nascent textbook mentioned below will be used as appropriate and several recent papers from peer reviewed journals like Nature, Science, Molecular Therapy, PNAS, Biochemistry, JBC etc.

Reference Books:

1. Donald Voet, Charlotte W. Pratt, Judith G. Voet**.** Principles of Biochemistry**, 4/e, Wiley, 2012.**
2. David L Nelson, Michael M Cox, Albert L Lehninger. Lehninger Principles of Biochemistry, **6/e New York : W.H. Freeman, 2013.**
3. Irwin H. Segel. Biochemical calculations: how to solve mathematical problems in general biochemistry, **2/e Wiley, 1976.**
4. T Palmer, P L Bonner. Enzymes, 2nd Edition Biochemistry, Biotechnology, Clinical Chemistry. **2/e Woodhead Publishing, 2007.**
5. Peter Tompa, Alan Fersht. Structure and Function of Intrinsically Disordered Proteins. **CRC Press, 2009.**
6. David Sheehan. Physical Biochemistry: Principles and Applications, **2/e Wiley, 2009.**

(4) **Course Name: Numerical Methods**
Course Number: MA 551
Credit: 3-0-0-3 (L-T-P-C)
Prerequisites: IC 110 (Engineering Mathematics), IC 111 (Linear Algebra)
Intended for: Third and Final year B.tech /MS/PhD
Distribution: Elective
Semester: Odd /Even
Faculty: Dr. Muslim Malik

Course Outline:
The course emphasizes the effective use of numerical analysis in applications require both a theoretical knowledge of the subject and computational experience with it. The theoretical knowledge should include an understanding of both the original problem being solved and of the numerical methods for its solution, including their derivation, error analysis and an idea of when they will perform well or poorly. Finally the primary objective of the course is to develop the basic understanding of the numerical methods, and perhaps more importantly, the applicability and limits of their appropriate use.

Course Modules:

Unit 1: Introduction -- Approximate Numbers and Significant Digits, Propagation of errors, Different types of errors, Backward error analysis, Sensitivity and conditioning, Stability and accuracy. [6 hour]

Unit 2: Nonlinear Equations: Bisection method, Newton's method and its variants, Secant method, Fixed point iterations and their Error analysis. [8 contact hour]

Unit 3: Finite differences, Polynomial interpolation, Newton Divided Differences, Spline interpolation. Numerical integration, Trapezoidal and Simpson's rules, Newton- Cotes formula, Gaussian quadrature, and Numerical differentiations.
[8 contact hour]

Unit4: System of linear equations: Gaussian Elimination, Partial Pivoting, Pivoting and Scaling in Gaussian Elimination method, Iteration methods, Error analysis. [8 contact hours]

Unit 5: Initial Value Problem (IVP): Taylor series method, Euler and modified Euler methods, Runge-Kutta methods, Multistep methods, Predictor-Corrector method. [6 contact hours]

Unit 6: Boundary Value Problem (BVP): Solution of Boundary Value Problem by Finite Difference Method. [6 contact hours]

Texts Books:

K. E. Atkinson, An Introduction to Numerical Analysis, 2nd Edition, John Wiley, 2008.
S. D. Conte and Carl de Boor, Elementary Numerical Analysis, McGraw Hill, 1988.

References:

M. T. Heath, Scientific Computing: An Introductory Survey, McGraw Hill, 2002.
A. Ralston and P. Rabinowitz, A First Course in Numerical Analysis, Dover Publications, 2001.

(5) Course Number: EE508
Course Name: Fundamentals of Electric Drives
Credits: 3-0-0-3
Prerequisites: Basic course in Power Electronics, Basic course in Electrical Machines
Intended for: UG/MS/PhD
Distribution: Elective for EE
Semester: Odd/Even
Faculty: Dr. Bhakti Joshi

Introduction: This is an introductory course in the field of electric drives and control and is intended as a pre-requisite for an advanced course in this field. In addition to giving a comprehensive idea about drives, this course will be helpful for students interested in doing projects in the field of electric drives and control. It is strongly recommended that the students opting for this course should have the basic knowledge of electric machines and power electronics.

By the end of this course, students will have learned the following:

- How to devise a control structure for a particular machine for a specified load
- How to analyse the drive control structure with respect to speed of response and stability
- Practical issues in drive operation

Course Outline:

- **Introduction to drives** (2 hours)
    - Importance of drives, Factors governing the choice of drives, Basics of drive dynamics, Types of load, Selection of motor power rating, *Applications*
- **DC motor drives** (17 hours)
    - Types of dc motors, starting and braking, transient analysis of separately excited motor with armature and field control (4 hours)
    - Controlled rectifier fed drives, multi-quadrant operation of separately excited dc motor fed from fully-controlled converter (4 hours)
    - Control of electric drives, closed loop torque, speed and position control, current and speed sensing (5 hours)
    - Chopper controlled dc drives (2 hours)
    - Supply harmonics, power factor and current ripple (2 hours)
- **Induction motor drives** (18 hours)
    - Induction motor operation with non-sinusoidal voltage supply, starting and braking of induction machines (4 hours)
    - Methods of speed control –stator voltage control, variable frequency control, *field weakening* (4 hours)
    - Voltage Source Inverter (VSI) control of induction motors (3 hours)
    - Current Source Inverter (CSI) control of induction motors (3 hours)
    - Current regulated VSI control (2 hours)
    - *Introduction to Vector Control* (2 hours)
- **Synchronous motor drives** (5 hours)

- Types of synchronous motors – Cylindrical-rotor and Salient-pole motors, Operation from fixed frequency supply – starting, braking, load disturbance transients
- Variable frequency control – true-synchronous mode, Self-controlled mode, Self-controlled Synchronous motor drive using Load Commutated Thyristor Inverter
- *Introduction to special machines – Permanent Magnet synchronous motor, Brushless dc motor etc.*

Reference material:

Textbooks

1. G. K. Dubey, Fundamentals of Electric Drives.

2. Dubey G. K., "Power Semiconductor Controlled Drives", Prentice Hall International Edition. 1989.

Reference books

3. Mohan N., Undeland T.M. and Robbins W.P., "Power Electronics –Converters, Applications and Design", 3rd Ed., Wiley India. 2008
4. Bose B.K., "Power Electronics and Variable Frequency Drives – Technology and Applications", IEEE Press, Standard Publisher Distributors. 2001
5. Rashid M., "Power Electronics- Circuits, Devices and Applications", 3rd Ed., Pearson Education.
6. Krause, P. C., Wasynczuk, O., Sudhoff, S. D., "Analysis of Electric Machinery and Drive Systems", New York, Wiley-Interscience.
7. *S. K. Pillai, A First Course on Electrical Drives, New Age International Pvt. Ltd.*

8. *R. Krishnan, Electric Motor Drives: Modeling, Analysis, and Control, Prentice Hall, 2001.*

9. *N. K. De and P. K. Sen, Electric Drives, Prentice-Hall of India Pvt. Ltd.*

(6) Course Number: New Course
Course Name: Popular Culture in Modern India: A Historical Perspective
Credits: 3-0-0-3
Prerequisites:
Intended for: UG
Distribution:
Semester:
Faculty: Dr. Devika Sethi

COURSE OUTLINE:

By reading and discussing the works of several scholars working on different manifestations of popular culture, this course aims at making students question the world around them, so that they can trace the origins and meanings of the culture they consume and create. The element of culture that is studied is connected to larger histories – for instance, what can cricket tell us about caste and class in India? What does our food have to do with migration and invasion? Does a new technology in the realm of music change its content? How do Indian films reflect economic liberalization? Do our calendars only tell us the date?

COURSE MODULES

1. **History of Cricket** (8 contact hours)
   - Unit 1: Race and Sport in Colonial India: Parsi cricket in India
   - Unit 2: Caste and Cricket in Colonial India: A Case Study of Palwankar Baloo
   - Unit 3: Class and Cricket: A Case Study of Maharaja Ranjitsinhji

2. **Popular Musical Traditions and Technology** (4 contact hours)
   - Unit 1: Oral Musical Traditions: A Survey (Bhands, Qawalls)
   - Unit 2: 'The Guru and the Gramophone' – Technology and Changes in Consumption of Music

3. **Popular Visual Culture** (10 contact hours)
   - Unit 1: What is Visual Culture?
   - Unit 2: Posters of National Leaders in the Colonial Period
   - Unit 3: Maps of India in Calendar Art

4. **Film and Advertisement History** (10 contact hours)

- Unit 1: Colonial Anxieties Regarding Film in India
- Unit 2: ‘Nation-building’ Cinema of the 1950s
- Unit 3: The Idea of the ‘Secular’ in Indian Films
- Unit 4: Changing Portrayals of the Villain in India
- Unit 5: Indian Cinema and Advertisements after Liberalization

5. **Food History** (10 contact hours)
   - Unit 1: Food in Ancient and Medieval India
   - Unit 2: Migration Patterns and Changes in Food Consumption
   - Unit 3: What is ‘Authentic’ Indian Cuisine?

Total contact hours: 42

Prescribed Texts:

1. A.R. Venkatachalapathy, *In Those Days There was No Coffee: Writings in Cultural History*, Yoda Press, New Delhi, 2006.
2. Rohit Wanchoo and Mukesh Williams (eds.) *Representing India: Literature, Politics, and Identities*, Oxford University Press India, New Delhi, 2008.
3. Dilip M. Menon (ed.) *Cultural History of Modern India*, Social Science Press, New Delhi, 2011.

Suggested Readings:

1. Ashis Nandy, *The Tao of Cricket: On Games of Destiny and the Destiny of Games*, Oxford University Press, New Delhi, 2001.

2. Ramachandra Guha, *A Corner of a Foreign Field: The Indian History of a British Sport*, Picador, New Delhi, 2002.

3. Peter Manuel, *Cassette Culture: Popular Music and Technology in North India*, University of Chicago Press, Chicago/London, 1993.

4. Christopher Pinney, *Photos of the Gods': The Printed Image and Political Struggle in India*, Reaktion Books, London, 2004.

5. Sumathi Ramaswami, *The Goddess and the Nation: Mapping Mother India*, Duke University Press, Durham, 2010.

6. Ravi S. Vasudevan (ed.) *Making Meaning in Indian Cinema*, Oxford University Press, New Delhi, 2001.

7. William Mazzarella, *Shoveling Smoke: Advertizing and Globalization in Contemporary India*, Duke University Press, Durham, 2003.

8. Rachel Dwyer, *Picture Abhi Baaki Hai: Bollywood as a Guide to Modern India*, Hachette, New Delhi, 2014.

9. K.T. Acharya, *A Historical Dictionary of Indian Food*, Oxford University Press, Oxford, 2003.

10. Lizzie Collingham, *Curry: A Tale of Cooks and Conquerors*, Vintage, London, 2006.

11. John Thieme and Ira Raja (eds.), *The Table is Laid: An Anthology of South Asian Food Writing*, Oxford University Press, Oxford, 2007.

(7) Course no.: ME 6xx
Course name: Applied Finite Element Method
Credits: 3
Pre-requisites: Desirable to have exposure to Solid mechanics, mathematics, Finite element method.
Intended for: Mechanical/Electrical BE 4th year/MS/PhD
Distribution: Electives for EE/ME/MS/PhD
Semester: Odd/Even
Faculty: Dr. O.P. Singh

Preamble: Graduate students including masters and PhD students study lots of theory of Finite Element Method but when comes to the application of theory in solving real world problems, they either lack the skill and/or don't know how to approach the problem. A real world problem involve all kind of physics and complex geometry simultaneously, for example, a car undergoes thermal, NVH, CFD, static loads, fatigue, linear and non-linear dynamics with various geometric shapes such as thin and thick sheets, thin and thick beam etc. Hence, students' needs practical exposure to such multidisciplinary problems. Keeping this in mind, this course has been designed to provide SKILL to the students on industry standard tools and practices using Applied FEM. At the end of the course, the students are expected learn the theory as well as quality meshing and analysis techniques of various types (1D, 2D, 3D) using variety of element types. Students will be given design problems and they are expected to solve it using FEM tools. This course is expected to provide hands-on experience to the students.

Course outline: The objective of this course is to introduce FEM as tool and how it can be used to analyze designs in various fields. This course would aid students in understanding the practical aspect of courses like FEM, design of machine elements, theory of machines, heat transfer etc. The course will also be taught be experts from various industries who have extensive experience in handling FEA tools and design processes.

Course Modules (42 hours)

Module 1: Basics of FEM, CAE driven design process, Analysis types: linear, non-linear, dynamic, buckling, thermal, Fatigue, optimization, CFD, NVH etc, 1D, 2D, 3D methods, Degree of freedom, Advantages of FEM, Modeling/Pre-processing techniques, introduction to meshing, common mistakes and errors, application of analysis types in various engineering fields. **(4 hours)**

Module 2: Introduction to meshing, when to use 1-D meshing, meshing in critical areas, element section, stiffness matrix derivation (direct method) and its properties, stiffness matrix for assembly of 2 rod elements, element types: beam element, rigid elements, fasteners, projects based on 1-D FEM, When to use 2-D elements, mid-surface, Constraint strain triangle, different types of element and their displacement function, Family of 2-D elements: plane stress, plan strain, plate, membrane, thin shell etc., effect of mesh density, effect of biasing in critical region, boundary conditions, how not to mesh, shrink wrap meshing, When to use 3-D elements, DOF for solid elements, Algorithms, brick meshing, how not to mesh, Hexa and Penta elements, solid map meshing **(12 hours)**

Module 3: Compatibility and mechanisms, spring elements, shells to solids, beam to solids, beams normal to shells, beam to shell edge, General element quality checks: skewness, aspect ratio, warpage, jacobian; 2-D quality checks, quality checks for tetra meshing, brick mesh quality checks, student projects on mesh quality, Hook's law, generalized Hook's law, material classification, material properties (**5 hours**)

Module 4: Various types of boundary conditions and constraints: thermal, hydrostatic pressure, gravity, torque, centrifugal, bending moments etc., examples from each fields, symmetric BCs, post-processing techniques (**3 hours**)

Module 5: Stiffness matrix, stress and strain calculations, FEM model for linear analysis, error analysis, projects based on linear analysis, introduction to buckling, elastic buckling, linear stability analysis, FEM model for buckling analysis, linear buckling of beam and wing structure, buckling with gravitation load, Introduction to nonlinearity, types of nonlinearity: geometric nonlinearity, material nonlinearity, boundary nonlinearity/contact nonlinearity, stress-strain measures, general procedures for nonlinear static analysis, plasticity **(10 hours)**

Module 6: Projects based on thermal analysis, CFD, Fatigue analysis, NVH analysis, Crash analysis etc. (**8 hours**)

Text books:

1. Practical Finite Element Analysis, by Nitin S.Gokhale, Sanjay S.Deshpande, Sanjeev V.Bedekar, Publisher: Finite To Infinite
2. Applied Finite Element Analysis by Larry J. Segerlind, Publisher: Wiley India Pvt Ltd; Second edition.
3. Applied Finite Element Analysis by G. Ramamurty, Publisher: I K International Publishing House Pvt. Ltd.
4. Finite Element Analysis: From Concepts to Applications David S. Burnett, Publisher: Addison Wesley
5. Finite Element Analysis for Engineering & Technology, by Tirupathi R. Chandrupatla, Publisher: Universities Press

Reference books:

1. Finite Elements for Electrical Engineers by Peter P. Silvester,, Ronald L. Ferrari, Publisher: Cambridge University Press
2. Finite Element Analysis of Electrical Machines by Sheppard J. Salon, Publisher: SPRINGER.
3. Introduction to Finite Elements in Engineering, by Belegundu Ashok D., Chandrupatla Tirupathi R., Publisher: Prentice-Hall.
4. Introduction to Finite Element Methods by P. N. Godbole, Publisher: I K International Publishing House Pvt. Ltd.
5. Concepts and Applications of Finite Element Analysis by Robert D. Cook, Malkus, Plesha, Witt, Publisher: Wiley India Private Limited
6. A First Course in the Finite Element Methods, by Logan, Publisher: Cengage.

Other Faculty interested in teaching this course: Rajeev Kumar, Md. Talha, Prasun Jana

(8) Course Name: Numerical Methods in Finance
Course Number: MA 565
Credit: 3-0-0-3 (L-T-P-C)
Prerequisites: IC 110: Engineering Mathematics, IC 111: Linear Algebra Intended for: MS/PhD/B.Tech.
Distribution: Elective
Semester: Odd /Even
Faculty: Dr. Rajendra K Ray

Preamble:
Finite difference theory has a long history and has been applied for more than 200 years to approximate the solutions of partial differential equations in the physical sciences and engineering. It is notable that the behaviour of a stock (or some other underlying) can be described by a stochastic differential equation. Then, a contingent claim that depends on the underlying is modelled by a partial differential equation in combination with some initial and boundary conditions. Solving this problem means that we have found the value for the contingent claim. Due to the complexity of these models it is very difficult to find exact or closed solutions for the pricing functions. Even if a closed solution can be found it may be very difficult to compute. For this and other reasons we need to resort to approximate methods. Our interest in this course lies in the application of the finite difference method (FDM) to these problems.

Course Outline:
The goal of this course is to develop robust, accurate and efficient numerical methods to price a number of derivative products in quantitative finance. We focus on one-factor and multi-factor models for a wide range of derivative products such as options and fixed income products. This course covers numerical methods relevant to solving the partial differential equations of mathematical finance. Theoretical and practical issues are treated. Topics include (but are not limited to): background material in ordinary and partial differential equations, examples of exact solutions including Black Scholes and its relatives, finite difference methods including algorithms and question of stability and

convergence, and a brief introduction to numerical methods for solving multi-factor models.
This course is a thorough introduction to FDM and how to use it to approximate the various kinds of partial differential equations in financial engineering.

Course Modules:

UNIT 1: THE CONTINUOUS THEORY OF PARTIAL DIFFERENTIAL EQUATIONS -- An Introduction to Ordinary Differential Equations, An Introduction to Partial Differential Equations, Second-Order Parabolic Differential Equations, An Introduction to the Heat Equation in One Dimension, An Introduction to the Method of Characteristics. [**8 lecture hours**]

UNIT 2: FINITE DIFFERENCE METHODS: THE FUNDAMENTALS – An Introduction to the Finite Difference Method, An Introduction to the Method of Lines, General Theory of the Finite Difference Method, Finite Difference Schemes for First-Order Partial Differential Equations, FDM for the One-Dimensional Convection–Diffusion Equation, Exponentially Fitted Finite Difference Schemes. [**8 lecture hours**]

UNIT 3: APPLYING FDM TO ONE-FACTOR INSTRUMENT PRICING - Exact Solutions and Explicit Finite Difference Method for One-Factor Models, Exponentially Fitted Difference Schemes for Barrier Options, Advanced Issues in Barrier and Lookback Option Modelling. [**8 lecture hours**]

UNIT 4: FDM FOR MULTIDIMENSIONAL PROBLEMS – Finite Difference Schemes for Multidimensional Problems, An Introduction to Alternating Direction Implicit and Splitting Methods, Advanced Operator Splitting Methods: Fractional Steps. [**8 lecture hours**]

UNIT 5: APPLYING FDM TO MULTI-FACTOR INSTRUMENT PRICING - Options with Stochastic Volatility: The Heston Model, Finite Difference Methods for Asian Options and Other 'Mixed' Problems, Multi-Asset Options, Finite Difference Methods for Fixed-Income Problems. [**10 lecture hours**]

Text book:
1. Daniel J. Duffy. *Finite Difference Methods in Financial Engineering: A Partial Differential Equation Approach*, John Wiley & Sons Ltd., 2006.

Reference Books:
1. Paolo Brandimarte. *Numerical Methods in Finance and Economics: A MATLAB-Based Introduction*. John Wiley & Sons INC., 2nd Edn., 2006.
2. John A. D. Appleby, David C. Edelman, John J. H. Miller. *Numerical Methods for Finance,* Taylor & Francis, 2008.
3. Michele Breton, Haten Ben-Ameur. *Numerical Methods in Finance*, Springer, 2005.

(9) Course Name: Metabolic Systems Biology

Course Number:

Credit: 3-0-0-3

Prerequisites: IC 136 - Understanding Biotechnology & its Applications or Consent of Faculty member

Students intended for: B. Tech. 3rd and 4th year, MS/M.Tech., Ph.D.

Elective or Compulsory: Elective

Semester: Odd/Even

Faculty : Dr Shyam Kumar Masakapalli

Course Objective: This course will introduce the concepts of modern systems biology approaches for studying metabolism. Metabolic profiling and measuring *in-vivo* reaction rates (i.e flux) via pathways provide critical insights into understanding the cellular physiology. The course introduces the aspects of computational, statistical and analytical methods and tools, with emphasis on understanding the biological aspects. Much focus is laid on introducing metabolomics and fluxomics that has wide range of applications in rational metabolic engineering. As a result of this course, the students will have strong foundations and first hand scientific understanding of current trends in Metabolic Systems Biology.

Course Outline:

Module 1 [6 Lectures]

Introduction to systems biology and metabolism: Components of Biological systems (DNA, RNA, Protein, Metabolites), their properties and function. Overview of cellular metabolism, enzyme kinetics and metabolic pathways. Online resources and Tools to study metabolism – KEGG, ECOCYC etc.

Module 2 [8 Lectures]

Introduction to -omics with focus on metabolomics: Biological networks and their significance – at the level of genome, transcriptome, proteome, metabolome and fluxome. Metabolomics - applications and its role in systems biology. Analytical methods for detecting and quantifying metabolites. General work flow and Statistical methods in metabolomics. Pathway and metabolome databases. Case study on metabolomics from literature.

Module 3 [14 Lectures]

Metabolic pathways, network reconstruction and constraint based flux analysis: Pathways of central and secondary metabolism in selected model systems (microbes, plant and animal), Reconstruction of metabolic networks, Stoichiometric matrix. Topological analysis of metabolic network with Elementary flux modes and/or Extreme pathways, Introduction to Constraint based metabolic modelling and Flux Balance analysis. Related software tools and online resources. Case study on Constraint based flux analysis from literature.

Module 4 [14 Lectures]

Introductory 13C based fluxomics: Metabolic Phenotypes, Fundamentals of Metabolic Flux analysis. Current practices of 13C Metabolic Flux Analysis – Stable isotope labelling, steady state vs Non-stationary, Isotopomer analysis, Carbon transition networks, mathematical modelling for quantifying fluxes (in-vivo reaction rates), Flux maps. Software tools and online resources. Case study on 13C metabolic flux analysis from literature.

Reference Books:

- **Introduction to Systems Biology,** Edited by Choi, Sangdun, Springer Publishers
- **Metabolomics – A powerful Tool in Systems Biology,** Edited by J.Nielsen and M.C. Jewett, Springer Publishers
- **Metabolic Flux Analysis-Methods and protocols** Edited by Jens O. Krömer, Lars K. Nielsen, Lars M. Blank, Springer Publishers
- Additional reference material and scientific papers will be provided.

(10) Course Title: Digital Image Processing

Course Credits structure: Lectures/Tutorials/Practicals/Total: 3-0-2-4
Course No.: EE 608
Students Intended for: UG/MS/PhD
Prerequisite: Basics of signal processing and Probability theory
Elective or Compulsory: Elective
Semester: Odd
Faculty: Dr. Anil K Sao

Preamble: The Visual experience is the principal way that humans sense and communicate with their world. We are visual being and images are being made increasing available to us in electronic digital format via digital camera, Internet, hand-held devices. With much of technology being introduced to the human life, digital image processing plays an important role in easing out the human processing. The objective of this course will be to cover fundamental of image processing and their applications. This course will take some real world problems that can be attacked with image processing

Course Outline:

1. **Introduction to digital image processing (3hr):** What is image processing, Different types of images, Visual perception, Image sensing and Acquisition, Quantization, Sampling, color image processing, Revision of Mathematical concepts for image processing

2. **Intensity transformation, Filtering in spatial and Frequency domain (8hr):** Image negatives, Log transformations, Histogram processing, Spatial filter: smoothing and Sharpening, Discrete Fourier transform, properties of 2-D DFT, Image smoothing and Sharpening in Fourier domain

3. **Image transforms (5hr):** Two-dimensional orthogonal and Unitary transforms, Optimum transform, Properties of Unitary transforms, 2D DFT, Cosine transforms, Hadamard transforms, KL transforms, Comparison of image transforms

4. **Edge detection (3hr):** Gradient and Laplacian based edge detection, Diffusion based edge detection: Isotropic and anisotropic diffusion.

5. **Wavelet transform for Image Processing (5hrs):** Multi resolution expansion, Wavelet functions, Wavelet Series expansion, Continuous and Discrete Wavelet transforms, Wavelet

transforms for two-dimensional signals (images), Applications of wavelet transforms for edge extraction, noise suppression.
6. **Image segmentation (5hr)**: Thresholding, region-based Morphological Watersheds, Bayesian based image segmentation.
7. **Image restoration and reconstruction (5hr)** : Models of image degradation, noise models, Spatial and Frequency domain based approaches for image restoration, Inverse filtering, Wiener Filtering, Bayesian denoising.
8. **Image Compression (4hr)**: Spatial and Temporal redundancy, Basic image compression models, compression standards, basic compression methods: Huffman coding, Run-length coding, Block transform coding, Predictive coding
9. **Color Image Processing (4hr)**: Color Fundamentals, Color Models, Color transformation, smoothing, sharpening and edge detection in color images.

Textbooks

1. R. C. Gonzalez and R. E. Woods, " Digital Image Processing" Third edition, Pearson Education, 2009
2. Anil K Jain, " Fundamental of Digital Image Processing", Prentice Hall, 1989

References:

1. A. C. Bovik, " The essential guide to image processing", Second edition, Academic Press,2009
2. A. M. Teckalp, " Digital Video Processing", Prentice Hall PTR, 1995

Other Sources: **None**

Other Faculty Member Intended in Teaching the Course: **Arnav Bhavsar**

(11) Course Number:
Course Name: Embedded Linux Connecting the Physical World to the Internet of Things
Credits:
Prerequisites: C programming and Linux experience. Willingness to dive in the middle of a project and figure it out on your own.
Intended for: UG/MS/PhD
Core or Elective: Elective
Semester:
Faculty: Dr. Mark A. Yoder

Preamble : Learn to connect the physical world to the Internet of Things (IoT) using embedded Linux on a BeagleBone Black (http://beagleboard.org/BLACK). This hands on hardware/software class starts with interfacing switches, sensors, motors, LEDs, etc. to the Bone using JavaScript, a highlevel scripting language. Next we use Linux's command line interface and then move to the C programming language. We learn how to talk to the IoT by sending and receiving tweets, texts, emails, etc. We then combine the physical with the IoT. For example flash an LED when a certain keyword is tweeted, or send a text message when the local temperature rises above a preset level. Finally we look at details of what happens from the time the Bone powers up to running
Linux kernel. We'll show how to work in the open source world including using git and http://github.com for source code management and the web for learning and sharing ideas. Class concludes with a major design project which combines the elements of the course.

Course Outline:

1. INTERFACING SWITCHES, SENSORS, MOTORS, LEDS, ETC. USING JAVASCRIPT (8 Hours)
2. USING git FOR CODE MANAGEMENT (2 hours)

3. LEARNING AND SHARING ON ELINUX.ORG (2 hours)
4. INTERFACING USING LINUX GPIO SUBSYSTEM (4 hours)
5. INTERFACING USING C PROGRAMMING LANGUAGE (4 hours)
6. TALKING TO THE INTERNET OF THINGS: EMAIL , TWEETING, TEXTING, ETC. (4 hours)
7. BOOT TIME SEQUENCE (4 hours)
8. LINUX KERNEL: COMPILING, MODULES (8 hours)

Reference Books:

1. “BeagleBone Cookbook: Software and Hardware Problems and Solutions”, by Mark A. Yoder and Jason Kridner, O’Reilly. (http://shop.oreilly.com/product/0636920033899.do)
2. “Exploring BeagleBone: Tools and Techniques for Building with Embedded Linux”, by Derek Molloy, Wiley.
(http://www.amazon.com/ExploringBeagleBoneTechniquesBuildingEmbedded/dp/1118935128)

(12) Course Name: Mathematical Physics
Course Number: PH411
Credits: (4-0-0-4)
Prerequisites: None
Intended for: UG/PG
Distribution: Core PG/Elective UG
Semester: Odd
Approved: No
Faculty: Dr. Pradyumna Pathak

Preamble: Mathematical physics provides firm foundation in various mathematical methods developed and used for understanding different physical phenomena. This is the first course provides mathematical tools to address formalisms used in the core course of masters level physics program.

Course outline: The course starts with concept of vectors and it’s generalizations and also it give introduction to vector calculus. This is followed by introduction of linear vectors space which is essential for understanding of many areas of physics including quantum mechanics. The course continues to introduce differential equations and special function that are used to understand physical phenomena in different geometries. This followed by complex analysis and finally Fourier analysis and integral transforms are discussed.

Modules:

Coordinate system, Vector calculus in Cartesian and Curvilinear coordinates, Tensor analysis, pseudo-tensor, dual tensors, Jacobian (10 lectures)

Linear vector spaces, Gram-Schmidt orthogonalization, Self -adjoint, Unitary, Hermitian, Operators, transformation of operators , eigenvalue equation, Hermitian eigenvalue problems, Hermitian matrix diagonalization. (10 lectures)

Ordinary differential equation (ODE) with constant coefficients, Second order Linear ODE, Series Solution- Frobenius Method, Inhomogeneous linear ODE. Sturm Liouville

equation Hermition operators - eigenvalue problem- variation method. Special functions, Bessel, Neumann, Henkel, Hermite, Legendre, Spherical Harmonics, Laguerre. (12 Lectures)
Special functions: Gamma, Beta, Delta functions. (6 lectures)
Complex variables and functions, Cauchy- Riemann conditions, Cauchy's Integral theorem , Laurent expansion, Singularities, Calculus of residues, evaluation of definite integrals, evaluation of sums. (10 lectures)
Fourier Series general properties and application, Integral transform, Properties of Fourier transform, Fourier Convolution theorem, Discrete Fourier transform, Laplace transform, Laplace convolution theorem. General introduction to integral transform.

Text books

1. Mathematical methods for physicists by Arfken and Weber
2. Mathematical Methods in Physical Sciences by Mary L Boas

References

1. Mathematical Methods for Physics and Engineering: A Comprehensive Guide by K. F. Riley , M. P. Hobson
2. Mathematical Methods for Physicists by Mathews, J., and Walker, R.L.,
3. Mathematics of Classical and Quantum Physics by F W Byron and R W Fuller
4. Methods of theoretical Physics Vol. I and II by P M Morse , H. Freshbach
5. Advanced Engineering Mathematics by E Kreyszing

(13) Course Name: Classical Mechanics

Course Number: PH412
Credits: (4-0-0-4)
Prerequisites: None
Intended for: UG/PG
Distribution: Core PG/Elective UG
Semester: Odd
Approved: No
Faculty: Dr. Prasanth P Jose

Preamble: Classical mechanics is one of the backbone of physics which deals in understanding the motion of particles. At the undergraduate level the students have studied elementary calculus based Newtonian mechanics. The present course covers, topics beyond the Newtonian mechanics for a proper base to understand quantum mechanics, solid state physics, nuclear physics, electrodynamics etc.

Course outline: The course discusses in detail central force problems, theory of small oscillations, Lagrangian formulations, Hamiltons equations, canonical transformations, Poisson brackets and Hamilton-Jacobi equations.

Introduction: Mechanics of a system of particles, constraints, DAlemberts Principle and Lagranges Equations, Simple Applications of the Lagrangian Formulation, Hamiltons principle, some techniques of the calculus of variations, derivation of Lagranges equations from Hamiltons principle, conservation theorems and symmetry properties. **(12 lectures)**
The Central Force Problem: The Equivalent one-dimensional problem, and classification of orbits, the virial theorem, the Kepler problem, the Laplace-Runge-Lenz vector **(4 lectures)**
The Kinematics of Rigid Body motion: Orthogonal transformations, Eulers theorem on the motion of a rigid body, finite rotations, infinitesimal rotations, rate of change of a vector, Angular momentum and kinetic energy of motion, the inertia tensor and the moment of inertia. **(8 lectures)**
Oscillations: Formulation of the problem, the eigenvalue equation and the principal axis transformation, small oscillations, frequencies of free vibration, and normal coordinates.

(8 lectures)
The Hamilton Equations of Motion: Legendre Transformations and the Hamilton Equations of Motion, Cyclic Coordinates and Conservation Theorems, The Principle of Least action.
(8 lectures)
Canonical Transformations: The equations of canonical transformation with examples, Poissons Bracket, Liouvilles theorem. **(8 lectures)**
Hamilton-Jacobi theory and Action-Angle Variables The Hamilton-Jacobi Equation for Hamiltons principle, The Hamilton-Jacobi equation for Hamiltons characteristic function, Separation of variables in the Hamilton-Jacobi Equation, Ignorable coordinates and the Kepler problem, Action-Angle Variables in systems of one degree of freedom. **(8 lectures)**

Text Books:

1. Classical Mechanics by H. Goldstein,
2. Classical Dynamics: A contemporary Approach by J.V.Jose and E.J. Saletan,
3. Classical Mechanics by N.C. Rana and P.S. Joag,

References:

1. The Variational Principles of Mechanics by Cornelius Lanczos
2. Mechanics by L.D. Landau and E.M. Lifshitz,
3. Introduction to Dynamics by I.C. Percival and D. Richards
4. A treatise on the analytical dynamics of particles and rigid bodies by E.T. Whittaker,
5. Classical mechanics by John R Taylor

(14) Course Name: Quantum Mechanics I

Course Number: PH413
Credits: (4-0-0-4)
Prerequisites: None
Intended for: UG/PG
Distribution: Core PG/Elective UG
Semester: Odd
Approved: No
Faculty: Dr. Pradeep Kumar

Preamble:
This course is an introductory level course on quantum mechanics covering the basic principles of quantum mechanics. Several applications of quantum mechanics will be discussed to train students to apply these ideas to model systems in both one-dimension and three-dimensions. Approximation techniques such as perturbation theory (both time dependent and time independent) and variational methods will be also discussed in this course.
Origins of quantum theory, Postulates of quantum mechanics, observables and operators, theory of measurement in quantum mechanics, state of the system and expectation values, time-evolution of the state, wave-packets, uncertainty principle, probability current, transition from quantum mechanics to classical mechanics-Ehrenfast theorem. **(6 lectures)**
Application of Schrdinger equation in 1-D: scattering, tunneling, bound states , harmonic oscillator, comparison of classical and quantum results **(6 lectures)**
Basic mathematical formalism of quantum mechanics, Dirac notation, linear vector operators, matrix representation of states and operators, commutator relations in quantum mechanics, commutator and uncertainity relations, complete set of commuting observables
(8 Lectures)
Theory of angular momentum in quantum mechanics, commutator relations in angular momentum, eigen values and eigen states of angular momentum, spin-angular momentum
(8 lectures)

Application of Schrdinger equation in 3-D models, symmetry and degeneracy , central potentials, Schrdinger equation in spherical co-ordinates, solution to hydrogen atom problem **(8 lectures)**
Time independent non-degenerate and degenerate perturbation theory, fine-structure of hydrogen, Zeeman effect and hyperfine splitting **(8 lectures)**
WKB approximation, variational method, Time-dependent perturbation theory, simple examples with two level systems, Fermi Golden rule, Transition induced by periodic external field, Dipole approximation and dipole selection rules, sudden and adiabatic approximation
(10 lectures)

Text books:

1. Quantum Mechanics -Vol.1, Cohen-Tannoudji, B Diu, F Laloe
2. Introduction to quantum mechanics-D J Griffith
3. Quantum Mechanics B. H. Bransden and C. J. Joachain

References:

1. Introductory Quantum Mechanics, R Liboff
2. Quantum physics of atoms and molecules-R Eisberg and R Resnick.
3. Modern Quantum Mechanics - J J Sakurai
4. Principles of Quantum Mechanics - R Shankar
5. The Feynmam Lectures in Physics, Vol. 3, R.P. Feynman, R.B. Leighton, and M. Sands, Narosa Publishing House, 1992.

(15) Course Name: Mathematical Foundations of Computer Science (M-FOCS)
Course Number: CS-208
Credits: 3-1-0-4
Prerequisites: IC-150
Intended for: B.Tech.
Distribution: Compulsory for CSE; CS elective for EE and ME
Semester: 3rd
Faculty: Dr. Satyajit Thakor

Objective: During the last two decades, there has been a major paradigm shift in processing, communication, and storage of information from predominantly analog domain to digital domain for the reasons such as ease of implementation, better efficiency, greater robustness against noise, and enhanced performance and security. This shift has not only resulted in generation of ever increasing volumes of digital data but also an acute need to efficiently process, store, and communicate it. To address this need the focus of CS curriculum must shift from introducing the traditional elementary discrete structures to represent and process the data to more abstract structures provided by abstract algebra and graph theory. This will enable the students to better understand and appreciate the current developments at the frontiers of CS, both in theory and application, and prepare them to contribute to further advancement of such frontiers.
On completion of this course, students should be able to demonstrate their understanding of and apply methods of discrete mathematics in CS to subsequent courses in algorithm design and

analysis, automata theory and computability, information systems, computer networks. In particular, students should be able to
- use logical notation to define fundamental mathematical concepts such as sets, relations, functions and various algebraic structures, reason mathematically using such structures, and evaluate arguments that use such structures.
- model and analyze a computation or communication process and construct elementary proofs based on such structures

Syllabus:

1. Fundamental structures:
Functions - surjections, injections, inverses, composition. (2 contact hours)
Relations - reflexivity, symmetry, transitivity, equivalence relations. (2 contact hours)
Sets - Venn diagrams, complements, Cartesian products, power sets, finite and infinite sets, introduction to lattices. (4 contact hours)
Abstract orders: quasi-order, partial order, well-order, (Advanced, optional topics: Zorn's lemma, Koenig's theorem.) (2 contact hours)

2. Combinatorics: Counting arguments/techniques; pigeonhole principle; cardinality and countability, the inclusion-exclusion principle, recurrence relations, generating functions. (5 contact hours)
Basics of graph theory: graph as a discrete structure, graph coloring and connectivity, traversal problems, and spanning trees. (5 contact hours)
Advanced, optional topic: Probabilistic method in combinatorics.

3. Logic: Propositional and predicate logic: syntax, semantics, soundeness, completeness, unification, inferencing, resolution principle, proof system. (6 contact hours)
Proof techniques (negation, contradiction, contraposition, mathematical induction) and the structure of formal proofs; efficiency of proof-systems. (4 contact hours)

4. State machines: Introduction, minimization, grammars, languages. (4 contact hours)

5. Algebra: Motivation for algebraic structures, the theory of some algebras such as monoids, groups (finite, cyclic, permutation, matrix), cosets, subgroups, Lagrange's theorem, discrete logarithm. (8 contact hours)
Optional topic:

6. Number Theory: Elementary number theory, fundamental theorem of arithmetic, gcd, unique factorization, Euler's function, modular arithmetic, Fermat's little theorem, Chinese remainder theorem, modular exponentiation, RSA public key encryption.

Suggested Reference Books:

1. E. Lehman, F. T. Leighton, and A. R. Meyer, *Mathematics for Computer Science*, 2013. Available online at: http://courses.csail.mit.edu/6.042/spring13/mcs.pdf

2. R. L. Graham, D. E. Knuth, and O. Patashnik, *Concrete Mathematics*, Pearson, 1994. Also, available online at: www.maths.ed.ac.uk/~aar/papers/knuthore.pdf

3. A. Aho and J. Ullman, *Foundations of Computer Science*, W. H. Freeman, 1992. Available online at: http://infolab.stanford.edu/~ullman/focs.html

4. I. N. Herstein, Topics in Algebra, 2/e, Wiley, 1975.

5. A. Tucker, *Applied Combinatorics*, 6/e, Wiley, 2012.

6. C. Liu and D. P. Mohapatra, *Elements of Discrete Mathematics*, 3/e, Tata-McGraw Hill, 2008.

7. T. Koshy, *Discrete Mathematics with Applications*, Academic Press, 2003.

8. J. Hein, *Discrete Structures, Logic, and Computability*, 3/e, Jones and Barlett, 2009.

(16) Course Name: Basic Immunology
Course Number: ????
Credit: 3-0-0-3
Prerequisites: IC 136 - Understanding Biotechnology & its Applications or or Consent of Faculty member
Students intended for: B. Tech. 3rd and 4th year, MS/M.Tech., Ph.D.
Elective or Compulsory: Elective
Semester: Odd/Even
Faculty: Dr. Amit Prasad

Course Objective: The purpose of the course is to give advanced knowledge in the area of immunology and will give the students insights into how such knowledge can be applied to problems in the field of biotechnology and biomedicine. Much emphasis is given on introducing immunology and its role in translational engineering. This course will enhance the thinking process of the student in both basic and applied aspects of immunology. At the end of the course student should be able to have independent thinking about the mechanism of immunology involved in various process. The interest and understanding developed will motivate the student to take up advanced immunology courses that has wide application in medicine and industry.

Course Outline:

UNIT I (8 lectures) INTRODUCTION TO IMMUNOLOGY

Objective: To know about the immune system and why we should read immunology

Cells of immune system; innate and acquired immunity; primary and secondary lymphoid organs; antigens: chemical and molecular nature; haptens; adjuvants; types of immune responses; theory of clonal selection

Session No	Topics to be covered	Time	Teaching Aids

		(min)	
1	Introduction to immunology	50	BB & Chalk
2	Cells of immune system	50	LCD
3	Innate and acquired immunity	50	LCD
4	Primary and secondary lymphoid organs	50	LCD
5	Antigens: chemical and molecular nature, Haptens and Adjuvants	50	LCD
6	Types of immune responses	50	LCD
7	Theory of clonal selection	50	LCD
8	Review	50	LCD

UNIT II (16 lectures) IMMUNE RESPONSES

Objective: To study about the cellular and humoral responses of immune system

Development, maturation, activation and differentiation of T-cells and B-cells; TCR; antibodies: structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions; monoclonal antibodies: principles and applications; antigen presenting cells; major histocompatibility complex; antigen processing and presentation; regulation of T-cell and B-cell responses.

Session No	Topics to be covered	Time	Teaching Aids
1	Introduction to cellular responses	50	BB & LCD
2	Development, maturation of T-cells and B-cells	60	LCD
3	Activation, differentiation of T-cells and B-cells	50	LCD
4	T-Cell Receptor	50	LCD
5	Antibodies: structure and functions	50	LCD
6	Antibodies: genes and generation of diversity	50	LCD
7	Antigen-antibody interaction	50	BB & LCD
8	Monoclonal antibodies, principles and applications	60	LCD
9	Antigen presenting cells	50	LCD
11	Major histocompatibility complex	50	BB & Chalk
12	Antigen processing and presentation	50	BB & Chalk
13	Regulation of T-cell responses.	50	BB & Chalk
14	Regulation of T-cell responses	50	LCD
15	Regulation of B-cell responses	50	
16	Review		

UNIT III (15 lectures) INFECTION AND IMMUNITY

Objective: To learn about infection and immune responses to an antigen, immunodeficiency and vaccines

Injury and inflammation; immune responses to infections: immunity to viruses, bacteria, fungi and parasites; cytokines; complement; immunosuppression, tolerance; allergy and hypersensitivity; Immunodeficiencies; resistance and immunization; Vaccines.

Session No	Topics to be covered	Time	Teaching Aids
1	Immune responses to pathogens	50	LCD
2	Immunity to viruses	50	LCD
3	Immunity to bacteria	50	LCD
4	Immunity to fungi and parasites	50	LCD
5	Cytokines and their biological roles	50	LCD
6	Complement system: classical and alternative pathway	50	LCD
7	Immunosuppression and tolerance	50	LCD
8	Allergy and hypersensitivity	50	LCD
9	Injury and inflammation	50	LCD
10	Injury and inflammation	50	LCD
11	Immunodeficiencies	50	LCD
12	Resistance and immunisation;	50	LCD
13	Vaccines.	50	LCD
14	Transplantation immunology	50	LCD
15	Review		LCD

UNIT IV (4 lectures) AUTOIMMUNITY
Objective: To learn about Autoimmunity

Autoimmunity, Autoimmune disorders and diagnosis

Session No	Topics to be covered	Time	Teaching Aids
1	Introduction to autoimmunity	50	BB & Chalk
2	Autoimmune disorders	50	LCD
3	Autoimmune disorders and diagnosis	50	LCD
4	Review		

TEXT BOOKS:
1. Kuby J, Immunology, WH Freeman & Co. 7th edition. MacMillan press.
2. Janeway, Charles A., et al. *Immunobiology: The Immune System in Health and Disease*. New York, NY: Garland Science
3. Roitt's Essential Immunology (Essentials) -Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt, publisher: Wiley-Blackwell, 2006

REFERNCES:
1. Fundamental Immunology- William E Paul, publisher: Lippincott Williams & Wilkins, 2008
2. Immunology, Infection, and Immunity -Gerald B. Pier,Jeffrey B. Lyczak, Lee M. Wetzler, publisher: ASM Press, 2004
3. Lecture Notes: Immunology, 5th Edition -Ian Todd, Gavin Spickett, publisher: Wiley - Blackwell, 2005
4. Immunology: A Short Course-Richard Coico, Geoffrey Sunshine, publisher: Wiley-Blackwell, 2009

(17) Course Name: Nanobiotechnology
Course Number: BY5XX
Credit: 3-0-0-3
Prerequisites: - IC 136 - Understanding Biotechnology & its Applications OR Consent of Faculty member
Students intended for: B. Tech. 3rd and 4th year, MS/MSc. /M.Tech., Ph.D.
Elective or Compulsory: Elective
Semester: Odd/Even
Faculty: Dr. Amit Jaiswal

Course Objective: The aim of this course is to give an introduction to different nanomaterials and their sensing and biomedical applications. The fundamental concepts of the unique properties of nanomaterials compared to those of bulk materials will be discussed in details. Since nanotechnology allures students from different backgrounds, the course will enable them to understand the nano-bio interface and how nanotechnology can be useful in several biotechnological applications. The course will essentially serve as a platform to interlink students from non-biology background at all levels.

Module I (15 L)
Introduction: Definition of nanotechnology, small-strange and useful, why go nano – unique properties of nanomaterials, history of nanotechnology, present and future of nanotechnology, Nano + Light, Engineering optical properties, Band gaps, exciton, quantum confinement, Different kinds of nanomaterials- Metal and semiconductor nanoparticles; Polymeric nanoparticles; Molecular nanoparticles, Forces at the nanoscale, The Nano-Biointerface.

Module II (15 L)
Nanobiosensing: Definition of sensors, different elements of sensor, introduction to nanobiosensing, Different types of biosensors, surface plasmon resonance based biosensor,

electrochemical and potentiometric based biosensor, motion, temperature, chemical, light and pressure sensitive biosensors, Applications of biosensors in molecule analysis; food safety, environmental and biomedical monitoring and detection of biological weapons, Lab on chip devices for sensing and detection.

Module III (12L)

Nanomedicine: Nanoparticle within a biological environment, Nanoparticle dynamics in biological media, nanoparticles for therapy- drug delivery, gene delivery, protein delivery, photothermal and photodynamic therapy, uptake and toxicology of nanomaterials, Nanoparticles based bioimaging.

Text & Reference Books:

1.**Nanotechnology: An Introduction**, by Jeremy Ramsden, 2011, *Elsevier Publishers*.
2.**Nanobiotechnology: Concepts, Applications and Perspectives**, edited by C.M. Niemeyer and C. A. Mirkin, 2012, Wiley-VCH Verlag GmbH & Co.
3**. Nanomedicine**, edited by Huw Summers, 2013, *Elsevier Publishers*.
4. **Nano-Bio-Sensing**, edited by Sandro Carrara, 2011, Springer Publishers Additionally, other latest research articles related to the topic will be discussed.

(18) Course Name: Data Mining For Decision Making
Course Number: CS 660
Credits: 3-0-1-4
Prerequisites: IC 210: Probability, Statistics and Random Processes; IC 250: Data Structure and Algorithms
Intended for: M.S./Ph.D./B. Tech. students
Distribution: Discipline elective for CSE; CS elective for EE and ME

Semester: odd/even
Faculty: Dr. Varun Dutt

Preamble:

In today's world, there is a rapid growth in data. Increasing amounts of data could be captured via the Internet, websites, point-of-sale devices, bar-code readers etc. Such data has tremendous relevance for managerial decisions. How could one find patterns in large amounts of collected data? This course titled, "Data Mining for Decision Making," involves learning a collection of techniques for extracting patterns and trends in large amounts of data. This course will provide a hands-on introduction to the data-mining area with an emphasis on aspects useful to business and management. Being built upon topics from artificial intelligence and statistical analyses, this course would form a good addition to the minor on Intelligent Systems at IIT Mandi.

Course Outline:

The course will cover a number of algorithmic techniques like Naïve Bayes classifiers, decision trees, neural networks, clustering, logistic regression, multiple-linear regression, principal components analysis, discriminant analysis, and association rules (market basket analysis). Furthermore, this course will help students better understand the need and appropriate place for data mining, the major techniques used in data mining, and the important pitfalls to watch out for in this area. Each week, three 1-hour lectures will cover theoretical concepts and techniques. Furthermore, each week, a 1-hour tutorial will provide hands-on practice on the taught techniques.

Modules:

The course is divided into weekly modules, where a new topic is covered in each week. The details of the topics covered in each week are provided below:

Week 1: Introduction to Data mining (3 hours)
What is Data Mining? What is the Data Mining Process? Basic Data Mining Tasks, Problem Identification, Data Mining Metrics, Data Cleaning (pre-processing, feature selection, data reduction, feature encoding, noise and missing values, etc.), Key Issues, Opportunities for Data Mining.

Week 2: Naïve Bayes classifier (3 hours)
Two-class classifiers, Training and Test sets, Maximum-Likelihood estimation, Bayesian estimation, Classification of Test sets.

Week 3: Decision Trees (3 hours)
Classification and Regression Trees, Building and Selecting Decision Trees (concept of Information Gain), Obtaining Production Rules from Decision Trees, Handling missing values in Decision Trees.

Week 4: Neural Networks (3 hours)
Introduction to Artificial Neural Networks, Single-layer Networks, Multi-layer Networks, Backward Propagation Algorithm, Annealing the learning rate (Step decay, Adagrad, and RMSprop), Over-fitting and choice of Epochs.

Week 5: Instance-Based Learning (3 hours)
Instances, Activations, Recency, Frequency, Retrieval from Memory, Blending of instances.

Week 6: Clustering (3 hours)
Introduction to Cluster Analysis, Clustering Algorithms, Hierarchical Methods (Nearest neighbor, Farthest neighbor, Group average), Similarity Measures.

Week 7: Logistic Regression (3 hours)
Introduction to Logistic Regression, Logistic function, odds ratio, logit, Logistic Regression with more than two classes

Week 8: Multiple-Linear Regression (3 hours)
Introduction to Multiple-Linear Regression, Assumption made in a linear regression model, regression process, dropping irrelevant variables.

Week 9: Principal Components Analysis (3 hours)
Introduction to principal components analysis, dimensionality reduction, principal components and orthogonal least squares.

Week 10: Discriminant Analysis (3 hours)
Introduction to discriminant analysis, applications to two-classes, extension to more than 2-classes, canonical variate loadings, extension to unequal covariance structures.

Week 11: Association Rules (3 hours)
Introduction to association rules, support, confidence, Apriori Algorithm.

Week 13: Implementation Issues (3 hours)
Metrics for Model selection - MDL, BIC, AIC, Ethics, Legality, and Privacy; Staffing and Implementation

Week 14: The Future of Data Mining, Unstructured Data Mining, and conclusions (3 hours)
If time permits:
Topics in graph mining: Definition of Graphs, Subgraphs, Frequent Subgraphs and subgraphs, Detection Algorithms: Apriori-Based Approach, Pattern Growth Approach (gSpan), Graph Classification, and Graph Compression.

Textbooks:

1. Hand David, Mannila Heikki, and Smyth Padhraic. Principles of Data Mining. Boston, MA: MIT, 2004. ISBN: 8120324579

References:

1. Han, J., Kamber, M. & Pei, J. (2012). Data mining concepts and techniques, third edition Morgan Kaufmann Publishers
2. Berry and Linoff. Mastering Data Mining. New York, NY: Wiley, 2000. ISBN: 0471331236.
3. Delmater and Hancock. Data Mining Explained. New York, NY: Digital Press, 2001. ISBN: 1555582311.
4. T. Mitchell. Machine Learning. New York, NY: McGraw-Hill, 1997.
5. M. H. Dunham. Data Mining: Introductory and Advanced Topics. Pearson Education. 2001.
6. Samatova, N. F., Hendrix, W., Jenkins, J., Padmanabhan, K., & Chakraborty, A. (Eds.). (2013). *Practical Graph Mining with R*. CRC Press.
7. Wang, H. (2010). Managing and mining graph data (Vol. 40). C. C. Aggarwal (Ed.). New York: Springer.

(19) Course Name: Managerial Thinking and Decision Making
Course Number: HS 616
Credits: 3-0-0-3
Prerequisites: IC 210 Probability, Statistics and Random Processes; or, with instructor's permission
Intended for: B. Tech./M.S./Ph.D. students
Distribution: SHSS elective for B. Tech. students; A core or elective course for M.S./Ph.D. students.
Semester: Odd, Even
Faculty: Dr. Varun Dutt

Preamble:

This course comes under the SHSS managerial competence basket and complement courses like the HS 304: Organizational Management and HS 403: Organizational Behavior. This course provides introduction to how thinking and decision making occurs in managerial settings. Topics covered include both descriptive and prescriptive decisions, i.e., on how managers actually make decisions, and how they ought to make decisions to maximize their outcomes. Students taking this course will learn how to improve one's decision making process and how to avoid common heuristic and biases in day-to-day decisions.

Course Outline:

This course builds upon the principles of judgment and decision making and applies these principles to managerial settings. The objective of this course is to expose students to techniques and tools that allow them to make improved decisions. Managers make decisions, often under uncertainty, and these decisions have important day-to-day consequences. Therefore, an understanding of managerial thinking and decision-making process should be an important component of education in engineering and management. Students taking this course will learn the normative (rational), descriptive (human), and prescriptive (how to) approaches to managerial decisions. Under these approaches, students would learn how factors like framing and valuation of outcomes and associated probabilities influence managerial choices for alternatives. Later part of this course will cover the role of heuristic and biases in a manager's day-to-day decisions and how managerial decision making and thinking takes places in groups.

Modules:

<u>Module 1</u>: Introduction to decision making: descriptive, normative, prescriptive styles (6 hours)
Introduction to decision making; Decision-making approaches: Descriptive (psychological), Normative (rational), and Prescriptive (pragmatic); Bounded rationality and satisficing.

<u>Module 2:</u> Introduction to decision analysis and problem framing (6 hours)
Study of decision analysis and technical tools for analyzing decisions; framing decisions, applications of decisions framing to marketing and management.

<u>Module 3:</u> Decision analyses for certain and uncertain (probabilistic) decision situations(8 hours)
Methods of decision-making under certainty; Methods of decision-making under risk and uncertainty; Sequential decisions and decision trees; Multi-Criteria decision analysis and methods of resolving tradeoffs and conflicting objectives.

<u>Module 4:</u> Prediction, forecasting, and judgments (8 hours)
Analytical methods for predictions; Anticipating and Forecasting using non-statistical methods; Role of Intuition versus Analysis in Judgments; Use of statistical (linear regression) models to capture human intuition; Judgment of Association and Causation; Counterfactual thinking.

<u>Module 5:</u> Biases and heuristics in decision making (8 hours)
Introduction to different heuristics and biases, endowment effect, loss aversion, status-quo bias, inter-temporal biases, availability, representativeness, anchoring-and-adjustment, illusion of control, overconfidence, and confirmation bias.

<u>Module 6:</u> Decision making in groups (6 hours)
From individual decision making to group decision processes; group polarization; groupthink; cognitive repairs; nudges; brainstorming; decision rules.

Textbooks:

J. Edward Russo & Paul Schoemaker. *Winning Decisions: Getting it Right the First Time*. 2002. New York: Doubleday.

John S. Hammond, Ralph L. Keeney, & Howard Raiffa. *Smart Choices: A Practical Guide to Making Better Decisions*. 1999. Boston: Harvard Business School Press.

Reference Books:

Allen, David (2009). Making it all Work: Winning at the Game of Work and the Business of Life. New York: Penguin (ISBN-10: 0143116622).

Ayres, I. (2007). Super Crunchers: Why Thinking-by-Numbers is the New Way to Be Smart. New York: Bantam Books (ISBN 0553384732).

Bazerman, M.H., & Moore, D. (2005, 7th ed). Judgment in Managerial Decision Making. New York: Wiley (ISBN-13: 978-0-470-04945-7).

Gigerenzer, G. (2000). *Adaptive Thinking: Rationality in the Real World.* New York: Oxford University Press.

Gigerenzer, G., Todd, P., & ABC Research Group. (1999). *Simple heuristics that make us smart.* New York: Oxford University Press.

Gladwell, M. (2005). *Blink:* The Power Of Thinking Without Thinking. New York: Back Bay Books (ISBN-10: 0316010669).

Hardman, D. (2009). Judgment and Decision Making: Psychological Perspectives. New York: Wiley (ISBN: 978-1-4051-2398-3)

Heath, C. & Heath, D. (2007). Made To Stick: Why Some Ideas Survive And Others Die. New York: Random House (ISBN: 10-1400064287).

Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.

Kahneman D., Slovic P., and Tversky, A. (Eds.) (1982) *Judgment Under Uncertainty: Heuristics and Biases*. New York: Cambridge University Press

Slovic, P. (2000). *The Perception of Risk*. Earthscan Publications.

Surowiecki, J. (2004). *The Wisdom of Crowds*. New York: Doubleday (ISBN 0-34-911605-9)

Articles:

Some journal articles on JSTOR and cases, articles, and teaching notes from Harvard Business School Press (http://harvardbusinessonline.hbsp.harvard.edu).

(20) Course No. : IC 150P Lab
Faulty: Dr. Varun Dutt
Course Topics

<u>Programming Assignment - 0:</u> Linux Commands and Text Editors

<u>Programming Assignment - 1:</u> Compilation and Debugging

Programming Assignment – 2: Assignment Statements

Programming Assignment – 3: Pointers

Programming Assignment – 4: Recursive Functions and Functions

Programming Assignment – 5: Control Statements and Loop Statements

Programming Assignment – 6: Arrays

Programming Assignment – 7: Strings

Programming Assignment – 8: Structures

Programming Assignment – 9: File Input/Output, Spread sheet

(21) Course Number: HS-
Course Name: Financial Management
Credits: 3-0-0-3
Prerequisites: Nil
Intended for: B. Tech
Distribution: HS Course
Semester: Odd
Faculty: Dr. Puran Singh

Course Modules:

Introduction to finance function: Introduction to finance function in corporate context, Time value of money, APR and EAR, Term structure and yield curve

- **Investment Decisions:** NPV rule & IRR rules, Rate of return, payback period, profitability index methods, EBIT, EBT, PAT, Free Cash Flows, Interest tax shield, Valuation of mutually exclusive projects, Nature of cash flows from bond investment, coupon, yield, par value, premium and discounted price of bonds, yield curve, corporate bonds, Nature of cash flows from equity investment, DDM, Dividend vs capital gain, Enterprise value, comparable valuation – EPS, PE multiple
- **Risk and Return**: Historical return, variance and standard deviation of returns, diversifiable and non-diversifiable risk, beta, CAPM, Equity cost, beta estimation, Debt cost, levered and unlevered cost of capital, levered and unlevered beta

- **Financing Decisions:** Capital structure – equity vs debt financing, MM Hypotheses, taxes and capital structure, Bankruptcy costs – direct and indirect, Agency cost of leverage, Asymmetric information and capital structure, pecking order hypothesis, Estimating working capital needs, Management of working capital
- **Dividend decisions:** Payout process and policies, Dividend versus share repurchase, Payout versus retention, Signaling with payout, taxes and dividend

- **Other Strategic Financial Decisions:** Primary market process for private and public firms, Valuation of shares, Strategic alternatives in M&A

Reference Books:

"Financial Management", Berk, DeMarzo and Thampy, Pearson, Indian Subcontinent Edition (latest Ed.)

"Case Problems in Finance", Kester, Ruback and Tufano, McGraw Hill (latest Ed.)

(22) Course Number: ME 502
Course Name: Nanomanufacturing
Proposed by: Viswanath Balakrishnan
Credits: 3-0-0-0
Prerequisites: None
Elective or Core: Elective
Intended for: B.Tech (3rd year onwards-all branches)/ M.Tech/ M.S/PhD

Preamble:
The research on nanotechnology is taking a rapid path towards nonmanufacturing to make the breakthroughs of nanoscience/technology in to practical reality. The economic and scientific promise of nanotechnology will not be realized, if we fail to move forward and show commercial viability. The main objective of the courser is to prepare the students to latest advances in both "top down" and "bottom up" approaches and to address the fundamental challenges in nonmanufacturing. Also the course will be motivated to understand the size reduction in the electronic, memory and energy devices and related progress in industry. This new elective course on nanomanufacturing will be complementary to the existing conventional courses in nanoscience and nanotechnology that focuses on underlying science. The designed course will also bridge the gap between the engineering (mechanical and electrical), industrial developments and underlying basic science research.

Course Outline:
Nanomanufacturing involves large scale, reliable, economic and controlled production of nano scale materials, structures, devices and products. This course will cover various aspects of nanomanufacturing with major emphasis on the growth of 1D (CNT, Si nanowire) and 2D nanostructures (Graphene and other 2D materials) from chemical vapor deposition, thin film deposition techniques, self-assembly, nanopatterning along with several lithography and fabrication techniques. This course also will include techniques involved in nanoscale characterization and fabrication.

Modules:

Module-1: Introduction to Nanotechnology and Nanomanufacturing:
Historical developments in size reduction, nanomanufacturing objectives and opportunities, size effects and quantum confinement in semiconductors, behavior of nanocrystalline materials, different types of nanostructures (zero, one and two dimensional) with specific examples, applications of nanotechnology, nanomanufacturing challenges. **(4 hours)**

Module-2: Characterizations/fabrication techniques for nanostructures:
Basic concepts in microscopy, evolution of microscopes, electron microscopy and scanning probe microscopy for structural, microstructural, topological analysis, atomic order and chemical compositional analysis. Application of microscopes in nanoscale characterizations. In- situ microscopy for the growth and fabrications of various nanostructures. Interface of microscopy with nanofabrication techniques. **(6 hour)**

Module-3: Top down approaches for nanomanufacturing (subtractive)
Concepts in top down nanomanufacturing, Mechanosynthesis-ball milling, Focused ion beam milling, thin film fabrication, thermal evaporation, E beam evaporation, Sputtering (DC, RF, reactive), thin film growth mechanism and stress evolution, Essentials of photolithography, E-

beam lithography, nanoimprint lithography, Etching methods for fabrication, dry etching and wet etching. **(8 hour)**

Module-4: Bottom up approaches for nanomanufacturing (additive)
Solution synthesis of nanostructures, basics of size and shape control, growth by aggregation and oriented attachment, growth from vapor phase, Atomic layer deposition, Chemical vapor deposition, Growth of carbon nanotubes, graphene and 2D materials, Vapor-liquid-solid method, Vapor phase epitaxy, Molecular beam epitaxy, Growth of important semiconductor materials; Si, GaN nanowires. **(8 hour)**

Module-5: Advanced nanomanufacturing techniques and assembly
Non lithographic techniques for nanomanufacturing, Template assisted methods, Template less nanopatterning, self-assembly, electric field assisted assembly. **(4 hour)**

Module-6: Highlights of Nanomanufacturing; Literature search &discussion on selected topics: Challenges and Applications of nanomanufacturing in electronics, display, nanomedicine, green energy building and smart surfaces. High rate nanomanufacturing; roll to roll manufacturing for nanomaterials. Industrial R& D activities, economics and environmental concerns. **(5 hours)**

References:

1. Nanomanufacturing Handbook, Ahemed Busnaina, CRC press, 2006
2. Fundamentals of Microfabrication and Nanotechnology, Marc J.Madou, CRC Press, 2011
3. Emerging nanotechnologies for manufacturing by Waqar Ahmed& M.J Jackson William Andrew Publishing, 2009
4. Open course materials (MIT & University of Michigan) and Journal articles

(23) Course Name: Bioinformatics Applications for Systems Analysis
Course Number: BY606
Credit: 2-0-2-3
Prerequisites: Knowledge of pattern recognition and artificial intelligence
Students intended for: B. Tech. 3rd & 4th year, M.S. and Ph.D.
Elective or Compulsory: Elective
Semester: Even
Faculty; Dr. Tulika Srivastava

Course Outline:

Objective:The course is aimed at providing a basic understanding to the students about bioinformatics methods and their in-depth applications for solving biological problems. The course will include practical sessions for the students to help them master some of the bioinformatics techniques from hands-on experience. The course may also involve a project/term-paper development towards important biological problems within the purview of the course.

Part I: Basic Bioinformatics

Introduction to Bioinformatics: What is Bioinformatics? What are the applications of Bioinformatics?

Introduction to Basic Biology:Introduction to basic biological processes to which bioinformatics methods will be mainly applied in this course.

Introduction to Basic Programming:Introduction to basic scripting in Linux/Unix environment and programming (Perl Language) routinely used for bioinformatics analysis.

Sequence and Molecular File formats: Introduction to different file formats used for biological data including GenBank, FASTA, EMBL, Clustal, Phylip, SwissProt. Sequence and molecular file conversion tools (ReadSeq, SeqVerter, etc.).

Databases in Bioinformatics: Introduction to different biological databases (NCBI, EMBL, DDBJ, PIR, SwissProt, etc.), their classification schemes, and biological database retrieval systems.

Part II: Bio-algorithms and Tools

Sequence Alignments:Introduction to concept of alignment, Scoring matrices (BLOSUM, PAM), Alignment algorithms for pairs of sequences (Dot Matrix method, Global vs. Local alignment, Dynamic Programming algorithm, Needleman-Wunsch algorithm, Smith Waterman algorithm), Heuristic methods (FASTA, BLAST) Multiple sequence alignment (DPA, Heuristic methods, Genetic Algorithm, Simulated annealing, Profile HMMs).

Gene Prediction Methods:What is gene prediction? Computational methods of gene prediction. Extrinsic vs. Intrinsic methods, Prokaryotic and Eukaryotic gene prediction methods and tools.

Molecular Phylogeny:Introduction to phenotypic and molecular phylogeny. Representation of phylogeny, Molecular clocks, Methods of phylogenetic construction, Evolutionary models (Jukes-Cantor one-parameter model, Kimura tow-parameter model), Maximum Parsimony method, Maximum Likelihood method,
Distance methods, UPGMA, Neighbor-Joining Method, Fitch-Margoliash method, Minimum Evolution, statistical evaluation of the obtained phylogenetic trees (bootstrapping, Jackknifing), software for phylogenetic analyses (PHYLIP, PAML, PAUP), Tree viewing.

Pathways and Systems Biology: Introduction to pathways and systems biology, Analysis of Pathways, Metabolic network properties, Metabolic control analysis, Simulation of cellular activities.

Text Book:

1. Bioinformatics: Methods and Applications Genomics, Proteomics, and Drug Discovery S.C. Rastogi, N.Mendiratta, P. Rastogi (3rd Edition) PHI Learning Private Limited New Delhi (2011)
2. Bioinformatics Principles and Applications. Z. Ghosh and B. Mallick Oxford University Press.

Other References:

1. Introduction to Bioinformatics. Arthur M. Lesk (3rd Edition) Oxford University Press.
2. Genes IX - 9th ed. Benjamin Lewin.

Articles:

Latest research articles will be advised related to the topic being taught.

(24) Course Name: Understanding Biotechnology & its Applications
Course Number: IC136
Credit: 3-0-0-3
Prerequisites: None
Students intended for: B. Tech. 1st year
Elective or Compulsory: Compulsory
Semester: Odd/Even
Faculty: Dr. Tulika Srivastava

Course Outline: (Total number of contact hours: 40 hours)

Objective: Broad objective of this course is to give an introduction to biotechnology and its applications in our daily life. This course will help students to get familiarized with various techniques that are used routinely towards this.

Unit 1(Number of contact hours – 1 hr): Introduction to "biotechnology" and the history of biotechnological developments with major milestones.

Unit 2(Number of contact hours – 3hrs): Basic biology: Brief introduction to genes and genomes.

Unit 3(Number of contact hours – 5 hrs): Introduction to recombinant DNA technology and its application to genomics.

Unit 4(Number of contact hours – 4 hrs): Introduction to proteins and their products.

Unit 5(Number of contact hours – 5 hrs): Microbial biotechnology.

Unit 6(Number of contact hours – 5 hrs): Plant biotechnology.

Unit 7(Number of contact hours – 5 hrs): Animal biotechnology.

Unit 8(Number of contact hours – 5 hrs): Bioremediation and environmental biotechnology.

Unit 9(Number of contact hours – 5 hrs): Medical biotechnology.

Unit 10(Number of contact hours – 2 hrs): Biotechnology regulations and ethics.

Text Book:

Introduction to Biotechnology (3rd Edition) by William J. Thieman and Michael A. Palladino published by Benjamin-Cummings publishing company.

Other References:

- Biotechnology for Beginners by Reinhard Renneberg published by Academic press.
- Basic Biotechnology 3rd Edition by Ratledge Colin published by Cambridge university press.