Ver.2-(30-07-2020)

UG Core Courses Syllabus – Monsoon 2020

S. No	Course Code	Course Name	Faculty Name(s)
1.	CS1.301	Algorithm Analysis and Design	Srinathan Kannan
2.	ICS331	Algorithms & Operating Systems	Lini Thomas
3.	SC3.202	Bioinformatics(H1)	Nita Parekh
4.	SC2.305	Chemical Kinetics and Reaction Dynamics (H2)	Harjinder Singh
5.	HS0.301	Classical Text Readings - I	Ashwin J + Don D'Cruz
6.	EC5.204	Communication and Controls in IoT	Sachin Chaudhari + Aftab
7.	CL3.202	Computational Linguistics II: Comp Semantics and Discourse parsing	Dipti M Sharma
8.	CS0.101	Computer Programming	Suresh Purini + Ziaul Choudhry (lab)
9.	CS3.301	Computer Systems Engineering-I	Krishna Reddy
10.	CN4.110	Computing in Sciences-1(H)	Prabhakar B
11.	CS4.301	Data and Applications (H2)	Kamal Karlapalem
12.	EC2.101	Digital Systems and Microcontrollers	Aftab Hussain + Anil + Hari
13.	MA5.101	Discrete Structures	Ashok Kumar Das
14.	EC2.102	Electronic Workshop-1 (H2)	Madhava Krishna
15.	HS7.001	Human Sciences Lab-1 (H2)	Radhika Krishnan + Vikram Pudi, and
16.	SC3.101	Introduction to Biology	Vinod PK
17.	CL1.101	Introduction to Linguistics-1	Aditi Mukherjee
18.	CL2.203	Language and Society	Radhika Mamidi
19.	HS8.101	Making of Contemporary World	Aniket Alam
20.	EC5.101	Networks Signals and Systems	Jayanthi Sivaswamy + Anshu Sarje
21.	MA6.102	Probability and Random Processes	Lalitha V
22.	MA6.101	Probability and Statistics	Pawan Kumar
23.	SC1.203	Quantum Mechanics	Subhadip Mitra
24.	MA4.101	Real Analysis	Lakshmi Burra
25.	SC1.110	Science I	Prabhakar B
26.	EC5.201	Signal Processing	Santosh Nannuru
27.	SC2.304	Spectroscopy(H1)	Marimuthu Krishnan
28.	SC3.203	Systems Biology(H2)	Vinod PK
29.	EC5.202	Systems Thinking	Spandan Roy + Vinod PK
30.	HS0.202	Thinking and Knowing in the Human Sciences - II	Radhika Krishnan + Aniket Alam

CS1.301 Algorithm Analysis & Design 3-1-0-4

Faculty: Kannan Srinathan

Pre-Requisite: Discrete Mathematics and Data Structures. Objective: To teach the basics of algorithm design and analysis. Course Topics: (A) Thinking towards a solution (algorithm design): This objective is usually achieved by studying several exemplary techniques like: (a) Divide and Conquer. (b) Greedy Paradigm. (c) Dynamic Programming. (d) Linear Programming. (e) Backtracking. (f) Branch-andBound etc. (B) Analyzing the efficacy (correctness) and efficiency (feasibility) of purported solutions: This objective is usually achieved through several relevant examples like: (a) Solving recurrence relations. (b) Proving the correctness of a few number-theoretic algorithms. (c) Matroid theory (for greedy algorithms). (d) Proofs of correctness (usually via induction) for several optimization algorithms. (e) Basic results in probability theory (for randomized algorithms). (C) Insightfully appreciating the inherent complexity of a given problem: This objective is usually achieved by proving lower bound results and studying basic complexity classes like: (a) The Class P. (b) The Class NP. (c) The Class NPC. (d) The Class BPP. (e) The Class BQP. (D) Understanding the limits of computing: This objective is usually achieved by studying: (a) Godel's incompleteness theorem. (b) Church-Turing hypothesis. (c) Proving Undecidability via diagonalization/reduction. (d) Quantum Computing. Preferred Text Books: (1). Cormen, Leiserson, Rivest, Stein. Introduction to Algorithms (3rd Ed), Prentice Hall of India. (2).Sipser Michael. Introduction to Theory of Computation, 2/e, Cengage Learnng. Outcome: The students would learn how (a) to think about solving computation problems, (b) to prove the correctness and goodness of their solutions, (c) to continually attempt at improving on their approach and (d) to recognize if and when an optimal solution is designed.

Course Assessment Plan (Monsoon 2020)

Assignments	-	10%
Project	-	30%
Term Paper	-	20%
Any other	-	40%

ICS331 Algorithms& Operating Systems 3-1-0-4

Faculty: Lini Thomas
Pre-Requisite: Data Structures and Programming

Objective: The plan is to introduce students to the twin topics of algorithms and operating systems. It is planned to be achieved by studying operating systems and switch to its algorithmic aspects to cover algorithmic details. For instance, paging strategies have lot of algorithmic aspects, especially considering also randomized online algorithms. The course will cover algorithms and operating systems in tandem, with one lect ure each week devoted to each of the themes.

Course Topics: Topics in Operating Systems: Basic concepts in Operating Systems, Process management, Memory management, File management, Resource management, Concurrency control, Inter-process communication. Tentative List of Topics in Algorithms: Basic concepts in Algorithms, Design methodologies, Greedy algorithms, Online algorithms with application to paging and power management, Advanced data structures for file management, Graph algorithms with application to resource management.

Preferred Text Books: 1) Introduction to Algorithms, Thomas H Corner and etc., Printice Hall, 2nd Edition. 2) Operating System Concepts, 8 th Edition, Silberschatz, Abraham and Galvin, Peter, Addison.

Outcome: Students should be able to apply formal concepts of algorithm design to problem solving. They should be able to argue about efficiency of algorithms, important design methodologies, and choose appropriate data structures as required to solve problems coming from VLSI, circuit design, system design, and so on. Given that the application areas may include systems with sizable complexity, multi -user support, and interface with other systems, certain principles of system design arising from the field of operating systems are appl icable. At the end of the course, students should be able to apply OS concepts such as processes, synchronization, memory, and file systems to system design.

Course Assessment Plan (Monsoon 2020)

Assignments	-	30%
Project	-	10%
Quiz	-	30%
Open Book Exam/ 30 MinQuiz	-	30%

SC3.202 Bioinformatics 3-1-0-2

Faculty Name: Nita Parekh

Core Course: CND-3 (Half Course)
Credits: 2 credits

Course Plan:
Lectures: 13
Tutorials: Biological Resources & Web-based tools
Mid-term Exams: 1
Quiz Exam: 1
Lab/Project Exam: 1
Final Exam: 1
Weekly Assignments
Project – Implementing DP for global and local alignments, UPGMA for phylogeny tree construction

Objective:

The objective of the course is to familiarize the students with available web-based bioinformatics resources (databases and tools), how to use them for analysis and extract information from them.

The various analyses that can be performed on genomic sequences, *viz*., kmer search, pairwise and multiple sequence alignments, sequence-based database search, phylogenetic reconstruction and gene prediction will be covered in the course.

Week-wise Plan:

Week 1

I Introduction (2 Lectures)

- Overview – Bioinformatics, Gene and Genome structure
- Gene Technology – Restriction Endonucleases, Cloning vectors
- DNA sequencing – PCR, cDNA and Whole Genome sequencing, NGS and third generation sequencing technologies

Week 2

II BioDatabases (1 Lectures)

- Major Bioinformatics Resources – NCBI, EBI, PubMed
- Primary Nucleotide and Proteins Databases - GenBank, UniProt, PDB
- Genome Browsers – Ensembl, UCSC

Week 2-4

III Sequence Alignment (5 Lectures)

Pairwise Alignment –

- Types of pairwise alignments – Global, Local and Overlap alignments
- Dot Plots, dynamic programming (DP) algorithm
- Scoring matrices for nucleotides and proteins and gap penalties
- Sequence-based Database Search algorithms – BLAST, FASTA

Multiple Alignment

- Algorithms for Global and Local MSA – DP, Progressive based (ClustalX), Iterative methods, motif search based methods

Week 5

IV Modeling Molecular Evolution – Phylogeny (3 Lectures)

- Markov models of base substitution

- Computing Phylogenetic Distances
- Phylogenetic Tree Construction Methods
- PHYLIP

Week 6

V Gene Prediction (2 Lectures)

- Gene Prediction approaches - Open Reading Frames, Homology search, Content-based methods, Markov models

References:

1. *Bioinformatics Sequence and Genome Analysis*, David W. Mount, Cold Spring Harbor Laboratory Press, 2001.
2. *Biological Sequence Analysis, Probabilistic Models of Proteins and Nucleic Acids*, Richard Durbin, Sean R. Eddy, Anders Kroghs and G. Mitchison, Cambridge University Press 1998.

Course Assessment Plan (Monsoon 2020)

Assignments	-	30%
Quiz	-	20%
Open Book Exam/ 30 Min Quiz	-	40%

SC2.305 Chemical Kinetics and Reaction Dynamics (H2) 3-1-0-2

Faculty Name: Harjinder Singh

TYPE-WHEN: Monsoon 2020-21

PRE-REQUISITE: ability to solve ordinary differential equations and elementary linear algebra (vectors, matrices)

OBJECTIVE: Imparting basic knowledge of Rate processes in molecular physics and chemistry – phenomenological modeling (kinetics) and understanding at a molecular level (in terms of electronic and other internal modes of motion)

COURSE TOPICS: (1L: 90 mins)

1. a) Empirical chemical kinetics: Experimental techniques; The rates of reactions; Integrated rate laws; Reactions approaching equilibrium; The temperature dependence of reaction rates; Accounting for the rate laws; Elementary reactions; Consecutive elementary reactions; Impact on biochemistry: The kinetics of the helix-coil transition in polypeptides; Unimolecular reactions (2L)

b) Chain reactions; The rate laws of chain reactions; Explosions; Polymerization kinetics; Stepwise polymerization; Chain polymerization; Homogeneous catalysis; Features of homogeneous catalysis; Enzymes (2L)

c) Photochemistry, Kinetics of photophysical and photochemical processes; Impact on: The chemistry of stratospheric ozone; Applications: Impact on environmental sciences, biochemistry and other areas.

2. Molecular Reaction Dynamics: Reactive encounters; Collision theory; Diffusion-controlled reactions; The material balance equation; (2L)

Transition state theory; The Eyring equation; Thermodynamic aspects; The dynamics of molecular collisions; Reactive collisions; Potential energy surfaces; Some results from experiments and calculations; (2L)

The investigation of reaction dynamics with ultrafast laser techniques; Electron transfer in homogeneous systems; The rates of electron transfer processes; Theory of electron transfer processes; Experimental results; Impact on biochemistry: Electron transfer in and between proteins (2L)

3. Special topics (oscillating reactions, etc.) : 1L

PREFERRED TEXT BOOKS:
1) Physical Chemistry, by P. W. Atkins.
2) Physical Chemistry by Berry, Rice and Ross
3) Chemical Kinetics by Keith Laidler

*REFERENCE BOOKS: (1) 10 copies; (2) 4 copies; (3) 4 copies

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Quiz	25%
Final Exam	50%
Assignments	25%

HS0.301 Classical Text Readings - I 3-1-0-4

Faculty Name: Ashwin J + Don D'Cruz

Note: Please use course code for previously existing course

TYPE-WHEN :

PRE-REQUISITE : None

OBJECTIVE : This course intends to familiarize students with classical texts which deal with ideas relating to state, legitimacy, citizenship, and political economy. It hopes to get students to see broad patterns across time and space over the last few millenia and between the Western canon as well as Indian thought. It will help the student get a grounding in political theory as well as some of the foundational ideas in organizing the economy.

COURSE TOPICS :
(please list the order in which they will be covered)

Ancient Greece

- Plato's *Republic*
- Aristotle's *Nicomachean Ethics*

Ancient India

- Buddha, *Dhammapada*
- Kautilya, *Arthashastra*

Modern

- Hobbes, *Leviathan*
- Rousseau, *On the social contract*
- Smith, *Wealth of Nations*
- Marx, *The Communist Manifesto*

In our times:

- Gandhi, *Hind Swaraj*
- Ambedkar, Annihilation of Caste
- Hannah Arendt, Eichmann in Jerusalem

PREFERRED TEXT BOOKS:

- Stanley Rosen (ed.), *The Philosopher's Handbook: Essential Readings from Plato to Kant*, New York: Random House, 2003
- Mitchell Cohen (ed.), *Princeton Readings in Political Thought – Essential Texts from Plato to Populism*, Princeton University Press: 2018
- M.K. Gandhi, *Hind Swaraj*, Rajpal Publishing, 2015
- F. Max Muller (trans.), *The Dhammapada: Wisdom of the Buddha*, Sweden: Wisehouse Classics, 2016
- Patrick Olivelle (trans.), *King, Governance and Law: Kautilya's Arthasastra*, Oxford University Press, 2014
- Valerian Rodrigues (ed.), *The Essential Writings of Dr. B.R. Ambedkar*, Oxford University Press, 2013.
- Plato, *Republic*. Translated by C.D.C. Reeve. 2004. Hackett Publishing.
- Aristotle, *Nicomachean Ethics*. Translated by C.D.C. Reeve. 2014. Hackett Publishing.

*REFERENCE BOOKS:

- Rajeev Bhargava and Ashok Acharya (eds.), *Political Theory: An Introduction*, Pearson India, 2008
- Upinder Singh, *Political Violence in Ancient India*, Harvard University Press, 2017
- Santas, G. (ed). 2006. *The Blackwell Guide to Plato's Republic*. Blackwell Publishing.

- Ferrari, G. (ed). 2007. *The Cambridge Companion to Plato's Republic*. Cambridge UP.
- Kraut, R. (ed). 2006. *The Blackwell Guide to Aristotle's Nicomachean Ethics*. Blackwell Publishing.
- Polansky, R. (ed.) 2014. *The Cambridge Companion to Aristotle's Nicomachean Ethics*. Cambridge UP

***PROJECT:**

GRADING PLAN:

Type of Evaluation	Weightage (in %)
In class assignments (6)	**5% each; total 30%**
Term Paper (2)	**10% each; total 20%**
Long form essay (2)	**20% each; total 40%**
Class participation	**10%**

OUTCOME: Upon completion of this course, students will be able to appreciate, analyze, and critically engage with canonical texts which form the foundation for our current thinking around political and economic theories and their limitations. By making sense of the political and economic world around us, they would be in a better position to understand and engage in contemporary debates surrounding these very pressing and relevant topics.

REMARKS: This course will be co-taught by Don Dcruz and Ashwin Jayanti. While Don Dcruz will be discussing texts from Ancient Greece, the rest of the discussions will be carried out by Ashwin Jayanti.

EC5.204 Communication and Controls in IoT (H1) 3-1-0-2

Faculty Name: Sachin Chaudhari +Aftab
TYPE-WHEN :
PRE-REQUISITE : No

OBJECTIVES :

COURSE TOPICS :
Introduction to IoT, Sensing, Actuation, Microcontroller based Embedded System Design, Interfacing of sensors and actuators, Basics of Networking, Communication Protocols 1: WiFi/Bluetooth/Zigbee/LoRaWAN/NB-IoT, Data Protocols: MQTT/CoAP, Sensor Networks, *Edge, Fog and CloudComputing*, Interoperability in IoT, Smart City Applications

PREFERRED TEXT BOOKS:

1. Raj Kamal, *Internet of Things,* McGraw Hill, 2018
2. O. Hersent, D. Boswarthick, O. Elloumi, *The Internet of Things*, Wiley, 2016

***REFERENCE BOOKS:**

1. D. Norris, *The Internet of Things*, McGraw Hill, 2015

2. A. Bahga and V. Madisetti, *Internet of Things*, University Press, 2016

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Quiz-1	**20%**
Mid SemExam	**60% (This will be our endSem)**
Assignments	**0**
Project	**Yes (20%)**
Other Evaluation _____	**0**

CL3.202 Computational Linguistics II: Comp Semantics and Discourse parsing 3-1-0-4

Faculty Name: Dipti M Sharma

TYPE-WHEN:

PRE-REQUISITE: CL-1 or NLP-1

OBJECTIVE

To introduce the students to apply the basic concepts of semantics and pragmatics computationally. For this the key notions emphasised are: understanding the structure of

texts, meaning in text, contextual interpretation of text and representation of meaning in context.

COURSE TOPICS

1. SEMANTICS: Meaning Representation
1.1. Word meaning : Sense and reference
Lexical semantic relations - Synonymy, Antonymy, Hyponymy, Troponymy, Meronymy, Metaphor and Metonymy; Polysemy and Homonymy.
Semantic fields. Lexical ambiguity. Content words and Function words.
Lexical ambiguity, context variation.
Word Sense Disambiguation

Building resources: Dictionaries, Ontologies, WordNets, VerbNets, VerbFrames
1.2 Formal Semantics : Formal representation of natural language - semantic features, semantic primitives. Variability and unambiguous representation. First order logic; Variables and quantifiers, Lambda notation. Inference. Event, state and time representation. Predicate logic. Proposition. Inference. Notation for representing a proposition.

1.3 Sentence Meaning : Propositional Content and Sentence meaning.
Properties of predicates - reflexive, symmetry, transitive.
Properties of a sentence : analytic, contradiction, entailment.
Semantic Role labelling

Resources: Dependency Treebanks, Propbanks, Framenet.

2. Computational Discourse Analysis
2.1 Discourse Cohesion
Studying Structure of text and coherence, Discourse connectives and relations
Rhetorical Structure theory
2.2. Coreference Chains, anaphora resolution, entity linking.
2.3. Sentiment Analysis. Humour Analysis.

3. Computational Pragmatics:
3.1 Language Understanding; Meaning beyond textual context; speaker's intention and hearer's inference; inference - bridging inferences, causal and spatial inferences, elaborative and restrictive inferences;
3.2 Dialogue Systems, dialogue acts.
3.3 Resources : Discourse Treebank, Coreference chains, dialogue data.

PREFERRED TEXT BOOKS

Daniel Jurafsky & James H. Martin (2000); Speech and Language Processing, Pearson Education/Prentice Hall.
James R. Hurford & Brendan Heasley (1983). SEMANTICS - a course book. Cambridge University Press.
Judith Greene (1986). Language Understanding - a cognitive approach. Open University Press.

REFERENCE BOOKS:

Lyons, John. (1977). Semantics. Cambridge University Press.
Levinson, Stephen C. (1983). Pragmatics. Cambridge University Press.
Leech, Geoffrey. (1983). Principles of Pragmatics. Longman.
Brown, G and Yule, G. (1983). Discourse Analysis. Cambridge University Press. Cutting, Joan (2002). Pragmatics and Discourse: A resource book for students. Allen, James (1994). Natural Language Understanding. Pearson.

PROJECT

Students will do one term project which will include issues related to semantics, pragmatics and discourse.

SEMINAR

Students will be expected to read research papers on various topics and present in class.

GRADING PLAN

Type of Evaluation	**Weightage (in %)**
Quiz-1	**10**
Mid SemExam	**—-**
Quiz-2	**10**
End Sem Exam	**30**
Assignments	**15**
Project	**25**
Seminar	**10**
Other Evaluation _____	

OUTCOME

Students will develop a good understanding of semantic and contextual analysis of texts, computational approaches for parsing a text and the type of data resources for semantic representation.

REMARKS:

CS0.101 Computer Programming 3-1-3-5

Faculty Name: Suresh Purini + Ziaul Choudhry (lab)

TYPE-WHEN : UG-Core-Monsoon

PRE-REQUISITE :

OBJECTIVE :

COURSE TOPICS:

Programming Language 'C' and programming: Basic Syntax and Semantics, Variables, Types, Expressions, Assignment statements, Conditional and Iterative Control Structures, Simple I/O, Functions and parameter passing, Strings and string processing, Pointers and References, Structures, Recursion. Algorithm development: Techniques of problem solving, Stepwise Refinement, Simple numerical examples, algorithms for searching and sorting, merging order lists. Examples taken from such areas as business applications involving data manipulation, and simulation involving games, Basic shell programming, Essential systems administration with shell scripting and elementary Python, Make files and automated builds,

PREFERRED TEXT BOOKS:

***REFERENCE BOOKS:**

***PROJECT:**

GRADING PLAN:

Type of Evaluation	**Weightage (in %)**
Quiz-2	**8**
Mid Sem-2 Exam	**15**
End Sem Exam	**25**
Assignments	**21**
Project	**-**
Lab exam-1	**11**
Lab Exam-2	**20**

OUTCOME: REMARKS:

CS3.301 Computer Systems Engineering-I 3-1-0-4

Faculty Name: Krishna Reddy P
TITLE : Computer System Engineering-I

TYPE-WHEN : Core-Monsoon
PRE-REQUISITE :
OBJECTIVE : Man is a tool making animal. For every tool, there is machine part and operating part. A computer system is also a tool that contains machine part and operating part. The operating part of a computer is called as "operating system". The operating sys tem abstracts the machine part of computer system in terms of simple services by hiding the details of the machine (hardware). The objective of this course is to (i) introduce a framework of engineering/computer

system design (ii) discuss important design ideas which have been evolved for building modern operating systems and (iii) study how these design ideas have been extended to build the componen ts of modern operating systems.

COURSE TOPICS:
(please list the order in which they will be covered)

Introduction (1 week); Thinking about systems (1 week); Process Management (2 weeks); CPU Scheduling (1 week), Process Synchronization (2 weeks); Deadlocks (1 week); Memory management (1.5 weeks), Virtual Memory (1.5 weeks), File Systems (1 week); Protection and Security (1 week); Other topics (1 week).

PREFERRED TEXT BOOKS: Text book:

1. Silberschatz, A, Galvin, P, Gagne, G. Operating system concepts, Addison-Wesley (latest edition)
2. Saltzer, Jerome H. and M. Frans Kaashoek. *Principles of Computer System Design: An Introduction, Part I*. Morgan Kaufmann, 2009. ISBN: 9780123749574.

*REFERENCE BOOKS:

1. Wlliam Stallings, Operating Systems, Prentice -Hall, (latest edition).
2. Charles Crowley, Operating systems: A design oriented approach, Tata McGraw -Hill (latest edition)
3. Tanenbaum, A., Modern Operating Systems, Prentice -Hall, Second Edition (latest edition.

***PROJECT:**

Experiments will be on the exposing the working of several system calls of LINUX OS: Installation: reversing a file; Shell writing ; Process communication: Bounded buffer, semaphores, shared memory, threads; Replace "ls" with lookup; Command line for /proc; Memory management

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Quiz1	7%
Mid Sem Exam	20%
Quiz2	8%
End Sem Exam	35%
Assignments (programming)	30%

OUTCOME:

After completing the course, the students will understand (i) key design ideas evolved since 1950 for building general systems and computer systems, (ii) the fundamental concepts of several computer operating systems such as SOLARIS, LINUX, WINDOWS and MAC, (iii) the solutions/options to interesting problems which have been encountered by the designers of the preceding operating systems, and (iv) the critical role of the operation system in designing several computer based systems like database systems, expert systems, web based information systems, real-time systems, multi-media systems, embedded systems and so on.

REMARKS: The lab is intensive

CN4.110 Computing in Sciences-1(H) 2-0-3-2

Faculty Name: Prabhakar B

TYPE-WHEN : I year CNS core – Monsoon-2020

PRE-REQUISITE : None

OBJECTIVE: This course intends to introduce application of computational methods based on quantum mechanics, statistical mechanics and classical mechanics to solve problems in chemistry and biology, especially applied to molecular systems. By the end of the semester, given a problem, the student will be able to conceive model systems, apply appropriate computational met hods to examine the molecules/molecular process, solve the problem and explain the reasons behind the observations

COURSE TOPICS:

(please list the order in which they will be covered)

(I) Application of quantum mechanical and density functional theory methods:

* Geometry optimization and frequency calculations: Cartesian and internal coordinate representations of molecular systems; Qualitative discussion on various quantum mechanical (QM) and density functional theory (DFT) methods; Discussion on basis sets to represent atomic orbitals in QM calculations.

* Analysis of a simple QM output: Examine the molecular orbitals, dipole moments, molecular orbital energy related quantities, electronic energies, thermochemical quantities, vibrational and Raman frequencies, normal modes of vibrations, etc.

* Reaction modeling and related analysis: Conformational analysis, Transition state optimization and rigorous characterization, intrinsic reaction coordinate calculations.

* Post-Hartree Fock ab initio calculations (MP2 and CCSD(T)); Density functional theory calculations.

(II) Application of classical and statistical mechanics:

* Visualization of complex biomolecules: Obtain structures of proteins, DNA, and RNA, visualize them and identify residues, nucleotides, secondary structures, different types of intramolecular forces and calculate simple geometric parameters.

* Molecular dynamics simulations: Set up a molecular dynamics (MD) simulation (molecule – identify & correct missing atoms/bonds; solvate with water; equilibration and production simulations); force field, periodic boundary conditions, ensembles (NVT and NPT), constraints, integration timestep.

* Analysis of MD trajectories: Validate the quality of the simulations, calculations of thermodynamic quantities, perform analysis on protein simulations followed by nucleic acids – geometries, energies, dynamic properties.

* Free energy calculations: Calculation of free energies for molecular processes – umbrella sampling, thermodynamic integration, metadynamics.

(III) Hybrid QM/MM methods: (time permitting)

* Conformational analysis of a dipeptide in aqueous medium using hybrid QM/MM method and compare with the QM (gas phase/ implicit solvent models) and MM.

PREFERRED TEXT BOOKS:

*** Molecular modeling by Andrew Leach**

*** Molecuar modeling for beginners by Alan Hinchliffe**

***REFERENCE BOOKS:**

* Modern quantum chemistry by Szabo and Ostlund

* Understanding molecular simulation by Frenkel and Smit

***PROJECT:**

* Each student will identify a problem on chemical/biological pr ocess, investigate using appropriate methods, analyze, and submit a report.

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**20**
Mid Sem-2 Exam	**20**
End Sem Exam	**20**
Assignments/Quiz	**20**
Project	**20**
Term Paper	
OtherEvaluation _____	

OUTCOME: By the end of the semester, given a problem, the student will be able to conceive model systems, apply appropriate computational methods to examine the molecules/molecular process, solve the problem and explain the reasons behind the observatio ns.

REMARKS:

CS4.301 Data and Applications (H2) 3-1-0-2

Faculty Name: Kamal Karlapalem

TYPE-WHEN: Institute Core for CSE, Offered in 3rd semester.

OBJECTIVE: Theory and practice of core database design and building complex applications accessing relational database

COURSE TOPICS:

Data, Database, Database System
Data Models, Conceptual Data Modeling, ER Models
Relational Data Model, Relational Algebra, Tuple Relational Calculus SQL, Constraints, Triggers, Database Connectivity, Applications Normalization, Relational Database Design

PREFERRED TEXT BOOKS:

Fundamentals of Database Systems, Elmasri and Navathe, 7th Edition, Person, 2017 Database System Concept, Silberschatz, Korth, Sudarshan, 2010
Database Management System, Ramakrishnan, Gehrke, McGraw Hill, 2014

***REFERENCE BOOKS:**

***PROJECT:**
Compulsory Components:

A group project to take the domain and design a database, populate a relational database, and build an application.

A lab exam on SQL skills

Course Assessment Plan (Monsoon 2020)

Assignments	-	20%
Project	-	45%
Any other	-	35%
Quiz	-	25%
Open Book Exam/ 30 Min Quiz	-	40%

OUTCOME:

A very good understanding of core concepts and practice of databases, database design, and application development with back-end relational databases.

REMARKS:

A cool first database course.

EC2.101 Digital Systems and Microcontrollers 3-1-3-5

Faculty Name: Aftab Hussain + Anil + Hari

Objective:

The objective of the DSM course is to expose students to fundamental concepts of digital design (combinatorial and sequential circuit design) and alongside see how such building blocks find its way into a popular micro controller such as an Arduino. The student shall also be introduced to controller architecture as a natural extension of combinatorial and sequential circuit design along with practical aspects of controller programming and interface.

Course Topics:

Boolean Algebra, Function Minimization, Number Systems, Combinatorial Circuit Design, I/O interface to microcontroller through combinatorial circuits, Comparator Circuits in microcontroller Latches, Flip Flops, FSM, Sequential Circuit Design, Timers, Registers and Counters, PWM Timers in Embedded Controllers, USART Registers in Embedded Micro Controllers, Controller Communication through Shift Registers Controller Programming and Interface

Reference Books:

1. Digital Design by Mano and Ciletti

2. ATMEGA-328 Datasheet

Grading Plan:
Mid-1 (20%),
Mid-II(20%),
End-Sem (30%),
Lab Exam (25%), Tutorials and Labs (5%)

MA5.101 Discrete Structures 3-1-0-4

Faculty Name: Ashok Kumar Das
TYPE-WHEN : UG-Core-Monsoon
PRE-REQUISITE:
OBJECTIVE:

COURSE TOPICS:

Logic, Propositional Equivalences, Predicates and Quantifiers Sets, Proof Techniques, Mathematical Induction, Contradiction, Counting Techniques, Pigeon Hole Principle.

Set Theory, Relation, Composition of Relation, Matrix Representation, Equivalence Relation, Partial order relation (Posets), Hasse diagram, Topological Sorting, Lattice, Functions, Permutation Functions

Definition and examples of simple graphs, Isomorphism, Connectedness, Adjacency, Subgraph, Matrix Representation. Eulerian and Hamiltonian graphs, Trees, Bipartite Graph, Simple Graph, Hall's Marriage Theorem.

Groups, Subgroups, Cosets, Lagrange's Theorem, Permutation Groups, Isomorphism, Ring, Field

Multinomial coefficients, Recurrence Relations, Generating functions, Combinations with repetitions, Linear algebraic equations with unit coefficients. Principles of inclusion, exclusion

PREFERRED TEXT BOOKS:

***REFERENCE BOOKS:**

***PROJECT:**

GRADING PLAN:

Type of Evaluation	**Weightage (in %)**
Quiz-1	**5**
Quiz-2	**10**
Mid Sem Exam	**30**

End Sem Exam	**40**
Assignments	**15**
Term Paper	
OtherEvaluation _____	

OUTCOME:

REMARKS:

EC2.102 Electronic Workshop-1 (H2) 2-0-3-2

Faculty Name: Madhava Krishna

Objective: 1. Development of various *skills* in using electronics instruments and circuit simulation tools. **2.** Understanding the stages and procedures in electronic circuit design.

Course Topics: 1. Familiarity with various electronics instruments and components **. 2.** Problem solving – block diagram level solution development. **3.** Stages in electronics circuit design: simulation, prototype development on breadboard and d esigning PCB layout. **4.**Using state-of- the-art microcontroller boards such as *Arduino* in project development.**5.** Using Arduino boards to interact with the physical world (sensing and actuation) **6.** Trouble shooting.

Outcome: 1. Increased motivation among students for electronic circuit design. **2.** More confidence in students in Electronics skills. **3**. Clear understanding of basic electronics concepts with hands-on experience. **4.**Advantages in further Electronics courses.

Grading:
Assignments: 30%
Performance in the Lab (includes spot viva): 30%
Final Project: 40%

HS7.001 Human Sciences Lab-1 (H2) 3-1-0-2

Faculty Name: Radhika Krishnan + Vikram Pudi, and others

TYPE-WHEN : September to November

FACULTY NAME: Nimmi Rangaswamy & Vikram Pudi

PRE-REQUISITE : None. First year/semester core course for CHD 2019.
OBJECTIVE: Preparatory hands-on practical training to strengthen research reading, writing,

communication and interpretative skills

COURSE TOPICS:

Class 1 – 4
Introduction to reading / writing leading to enhanced communication and writing skills – this will be general in nature with regard to learning material with a focus on research oriented writing

1. Reading classic and simple research monographs; published literary diaries/notes
2. Reading short literary pieces from a variety of English texts – to understand styles/formats; identifying the voice; setting context
3. Exercises in writing – Simple to complex. Setting the tone and texture; Voice; Style
4. Exercises in writing – to convey an idea; interpreting a subject/voice; explaining points of view

Class 5
Historical writing and interpretation – understanding chronology; what is historical data; setting historical context to data;
Class 6
Sociological writing – Explaining the social context
Class 7
Ethnographic writing – from observation to description
Class 8 & 9
Algorithmic Thinking – Number guessing game, Divide and Conquer
Class 10
Data Modeling
Class 11
Algorithmic Thinking – Travelling salesman
Class 12
Surveys and Estimating Large Quantities
Class 13
Optimization / Constraint satisfaction

PREFERRED TEXT BOOKS:

1. Notes and Queries in Anthropology, The Royal Anthropological Institutes

2. A Diary in a Strict Sense, Bronislaw Malinowski

GRADING PLAN:

Class exercises- 30% - 3 or 4 class exercises conducted through the course

Mid-Course Exam/Quiz – 30% - will be an exam on topics covered

Final Exam – 40% - End of course exam

OUTCOME:

The Lab will introduce, hone and enhance reading, writing and interpretative skills to cope with the CHD programmes over the years. Students will be trained develop a good grasp of distilling a research work to its core meaning while drawing out their implication and affectations. The lab will provide techniques to write a research work with clarity and economy.

SC3.101 Introduction to Biology 3-1-0-4

Faculty Name: Vinod PK
TYPE-WHEN:

PRE-REQUISITE:

OBJECTIVE: To understand the molecular logic of life and connect it to topics in computational and systems biology

COURSE TOPICS:

o Time and length scales in biology

o Cellular foundations: Cell organelles, Membranes and cellular compartments, Tree of life

o Chemical foundations: Biomolecules, Structure and function

o Physical foundations: Bioenergetics, Catalysis, Enzymes, Photosynthesis, Respiration

o How cells obtain energy from the food - metabolism

o Genetic foundations: DNA, Chromosomes, and Genomes

o Evolutionary foundations, Systematics

o Basic concepts of gene, Mendelian principles, Mutations

o DNA Replication, Repair, and Recombination - an overview

o How Cells Read the Genome: From DNA to Protein

o Control of Gene expression

o Analysing and manipulating DNA – an overview

o Cell Signalling, Cell division and death

o Cells in their social context- Differentiations, multicellular organisms, tissues/organs

o Disease and defense mechanisms, Infectious disease (one case study)

o Systems thinking in Biology

o Big data in Biology

o Computers in Biology – an overview

PREFERRED TEXT BOOKS:

1. Fundamentals of Biochemistry by Voet, Voet & Pratt

2. Lehninger Principles of Biochemistry by David Nelson, Michael Cox

3. Molecular biology of the cell, Sixth Edition by Alberts B., et al

OUTCOME:

After successfully completing the course, students are expected to have a basic understanding of the biological concepts required to tackle problems in computational biology, bioinformatics and systems biology.

Course Assessment Plan (Monsoon 2020)

Assignments	-	30%
Any other	-	10%
Quiz	-	30%
Open Book Exam/ 30 Min Quiz	-	30%

CL1.101 Introduction to Linguistics-1 3-1-0-4

Faculty Name: Aditi Mukherjee

Type When: Monsoon 2020
PRE-REQUISITE: XX

OBJECTIVE: To provide a bird's eyeview of the area of linguistics to the students, so that they have an understanding of what is the domain of linguistics and why would it be relevant for computational linguistics

COURSE TOPICS:

1. **What is language?** Difference between human language and Animal languages. ***(3 hrs. [2])***

Natural language, Formal language and Artificial language, Characteristic features of human language,

what we know about language.

2. **Study of Human language – the field of Linguistics** ***(Total 30 hrs. [20])***

Looking at language from synchronic and diachronic points of view

Areas of Study

2.1 From structural perspective **(25.5 hrs. [17])**

a) Syntagmatic and paradigmatic aspects of language structure, Levels of structural analysis: Phonetics: Place and manner of articulation of speech sounds, IPA. **(4.5 hrs. [3])**

Phonology: Phone, phoneme, allophone; Distinctive features; Phonological rules; Syllable.

(6 hrs. [4])

Morphology: Units of word's internal structure, word formation processes, inflectional and derivational morphology, compound words and how they are formed. **(7.5 hrs. [5])**

Syntax: Types of sentences, Sentence structures, Phrase structure grammar. **(7.5 hrs. [5])**

b) From evolution perspective: Historical Linguistics **(1.5 hrs. [1])**

c) From usage perspective: Sociolinguistics **(1.5 hrs. [1])**

d) From Psychological perspective: Mechanisms of language acquisition, knowing more than one language **(1.5 hrs. [1])**

2.2. **Indian Grammatical Tradition:** A communication model for language study. Paninian grammatical model. ***(6 hrs.[4])***

2.3. **Writing Systems:** Representing language through graphic characters. ***(1.5 hrs. [1])***

GRADING:

Assignments: 15%, Mid Sem: 30%, End Sem : 35% and Project : 20%

PROJECT: The students will work on a hands on project on language analysis. In the project they are expected to work with real time data and understand its nature.

PREFERRED TEXT BOOK:

Language: Nature, Psychology and Grammatical Aspects by Victoria Fromkin, Robert Rodman and Nina Hyams, Cenage Learning (Indian Edition)

REFERENCE BOOKS:

1. **Linguistics** by Jean Aitchison, 5th edition. London: Hodder Headline, Teach Yourself Books, 1999. ISBN: 0-340-73733-6. Retitled and reprinted with corrections as: ***Linguistics: An Introduction***. 2nd edition. London: Hodder Headline, 1999. ISBN: 0-340-75792-2).

2. **Introduction to Language by** Fromkin, V.A. and Rodman, R., 1997. Harcourt Brace. 6th edition

OUTCOME:

The student will get a general picture of various aspects of language. The student will also get familiar with some basic concepts of linguistics and the methods to carry out language analysis.

CL2.203 Language and Society 3-1-0-4

Faculty Name: Radhika Mamidi

TYPE-WHEN : Monsoon 2020

PRE-REQUISITE : Introduction to Linguistics (suggested)

OBJECTIVE : The students will be introduced to the social aspects of language. The focus will be on exploring how language and society are intricately related: the politics of language in society, language and power, consequences of language contact, language variation with focus on users and the use, language and social media, cross-cultural communication in changing times.

COURSE TOPICS :

1. Language Variation: Language, Dialects and Varieties. Speech Communities. Regional and social dialects. Approaches to study variation systematically in the social context. Sociolinguistics and sociology of language.

2. Social stratification of language. Inherent variability. Sociolinguistic variables: indicator, marker, stereotype. Style shifting. Hypercorrection. Language variation and language change. Social motivation for sound change.

3. Language Contact: Bilingualism/Multilingualism, borrowing, code mixing/switching, pidginization and creolization, convergence, language maintenance/shift, language acquisition in a multilingual setting. Diglossia with or without bilingualism.

4. Sociolinguistic devices for effective communication. Communicative competence. Politeness strategies. Pronouns of power and solidarity.

5. Critical Sociolinguistics. Language and power; Language and social attitudes; Language and gender

6. Language planning: codification and elaboration. Language standardization.

7. Socio-pragmatics issues: Cross-Cultural communication; Politeness and Face Management in different communities

8. Social media language: Language use and Language analysis; Online identity; Social Networks; Online communities; Computer-mediated Communication; flaming, trolling, social norms, emoji, shared spaces; Social media language data analysis

PREFERRED TEXT BOOKS:

Trudgill, Peter (2000). Sociolinguistics: An Introduction to language and society (4th edition). UK: Pearson.
Wardhaugh, R., & Fuller, J. M. (2015). An Introduction to Sociolinguistics (7th edition). UK: Blackwell.
Holmes, Janet (2008). An Introduction to Sociolinguistics (3rd edition). UK: Pearson.

REFERENCE BOOKS:

Mesthrie, Rajand, Joan Swann, Andrea Deumert, and William L. Leap (2000) Introducing Sociolinguistics. Edinburgh University Press.
Romaine, Suzanne (2001) Language in Society. Oxford University Press. Second edition. Brown, P., Levinson, S.C., 1987[1978]. Politeness: Some Universals in Language Use.
Cambridge University Press, Cambridge, UK.

Brown, R., Gilman, A., 1968[1960]. Pronouns of power and solidarity. In: Fishman, J. (Ed.), Readings in the Sociology of Language. Mouton, The Hague, Netherlands, pp. 252–276.
Related videos by experts will also be used.

GRADING CRITERIA

Two major factors that will be determine the grade are:

(i) Sincerity and Ethics followed in the virtual mode of teaching.
(ii) Commitment and perseverance reflected in learning.

Attendance, participation and contribution to class by sharing interesting articles or videos is highly encouraged.

Assessment Scheme:
In-class Activities and Home-based Activities done individually, in pairs and in groups of 4. No exams.

1. **[AUGUST last week] Group work:** Each group of 4 will be assigned a task which includes data collection and analysis. Quantitative and Qualitative methodology to be followed. **[10%]**

2. **[SEPTEMBER last week] Pair work Seminar presentation:** Each pair of students [from the above group] will summarise and present 4 research papers – 2 papers each – related to the same task. Chapters from a book may be included as well, **[20%]**

3. **[OCTOBER last week] Micro presentations:** The students will choose a topic (from a list given), work on it with a sample data and lead a discussion over the topic with other students. **[10%]**

4. **Research projects/papers:** This will be assessed through the semester.

[By Mid-SEPTEMBER] Step 1: Students will explore some aspect of sociolinguistics, collect data, read relevant papers, and present their findings. **[10%]**

[By Mid-OCTOBER] Step 2: They will write a 1000 – 1500 word paper as the mid-term assignment discussing their findings by analyse the data collected. **[20%]**

[By Mid-NOVEMBER] Step 3: Final report submission and presentation. Students are expected to formally present their final research projects to the class. **[20%]**

5. We will have a CLASS BLOG. All contributions relevant to the course will be assessed on a weekly basis through the semester. [10%]

OUTCOME: Greater awareness of the social dynamics of language.

Course Assessment Plan (Monsoon 2020)

Assignments	-	50%
Project	-	50%

ASSIGNMENTS: Group tasks [10], Micro-presentations [10], 2 Seminars [20], Blog contribution [10]; PROJECT: 50 [in 3 phases - 10+20+20]

HS8.101 Making of Contemporary World 3-1-0-4

Faculty Name: Aniket Alam

TYPE-WHEN : CHD Core, Semester 1

PRE-REQUISITE : Admission to Human Sciences Dual Degree Program

OBJECTIVE: This course will inform the student about the world in which they live. Rather than taking a chronological order, it will look at a few landmark events and processes which marked and produced our world. It is meant to fill in the information gap which students will have about the world we live in, but also give them a sense of how different disciplines and scholars look at the world, how the same processes often play out in different "fields" and how one influences the other. The objective is to both inform the students about the contemporary world and how it came to be, and to appreciate the various strands, the diversity of ideas and practices, which constitute it. The objective is also to teach the student how to analyse social, economic, political and intellectual trends in the world in which they will work and live. It will bring them up-to-speed to the moment of digital transformations they are living through.

COURSE TOPICS: This course will be divided into six modules. These are

1. Maps and Books: How the world was "discovered" and "known" by the Europeans over the last five centuries. How this created the nations, cultures, knowledge's, and geopolitics of our contemporary world.

2. Revolutions (American, French, Russian, Iranian): Look at these as embodying important idea(l)s of our contemporary world, like political representation, fundamental rights, redistribution, and indigenis m. Introduce students to the global significance of each and why they remain contemporary.

3. Wars (Liberation Wars of Haiti and Vietnam; World Wars): These will look at the two main types of modern warfare which have defined our world, the wars of liberation and the wars of European loot an d division of the world.

4. Energy (Muscle, Solar, Hydrocarbons, Nuclear): These lectures will focus on how changes in energy use have made the industrial revolution possible, the manner of urbanisation, travel and communications. How forms of energy use and debates about them remain s central to our contemporary world.

5. Representation (Novel, Films, Photography, Social Media): These lectures will look at how new cultural forms have developed to give expression to the modern self and how these provide the context in which we understand ourselves.

6. Philosophical Foundations: This module will look at the emergence of ideas and practices of equality, liberty, fraternity, secularism, progress, etc in different parts of the world over the past five centuries. The first lecture will lay the broad outlines of the course, the topics to be covered and the context in which these are being taught. The last three lectures will bring the students up to the current digitally mediated world and leave them with ideas about what questions the humanities and social sciences is asking, and can ask of the contemporary times, and how.

PREFERRED TEXT BOOKS: Select chapters and themes from the following books will comprise the course textbook.

1. C. A. Bayly: *The Birth of the Modern World – 1780 – 1914*
2. C. A. Baylu: *Remaking the Modern World: 1900 – 2015*
3. Howard Zinn: *A People's History of the World*
4. Micheal Spence: *The Next Convergence: The Future of Economic Growth in a Multispeed World*
5. Jurgen Osterhammel: *The Transformation of the World: A Global History of the 19th Century*
6. Immanuel Wallerstein: *Historical Capitalism*
7. Amiya K. Bagchi: *The Political Economy of Underdevelopment*
8. Michael Williams: *Deforesting the Earth: From Prehistory to Global Crisis*
9. Max Weber: *The Protestant Ethic and the Spirit of Capitalism*
10. Nathan Watchel: *The Vision of the Vanquished – The Spanish Conquest of Peru Through Indian Eyes, 1530-1570*
11. Max Tegmark, *Life 3.0: Being Human in the Age of Artificial Intelligence.*

***REFERENCE BOOKS:** Students will be given readings from various books and articles related to the topics being covered in class. A list of additional readings will also be given for term papers and for students who want to read more on a particular topic.

***PROJECT:** Each student will take a specified topic from within the course and study it in great detail. S/he will build a cross disciplinary report on that topic and try out computational methods to analyse it. The project topics will be given out after the first Quiz and will have to be worked on in consultation with the main instructor. The project will have to be presented in class.

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Quiz-1	7.5%
Quiz-2	7.5%
Mid Sem Exam	15%
Assignments (four)	20%
End Sem Exam	30%
Lab Exam	0%
Project	20%

OUTCOME: The student will come to know of the important landmarks of the contemporary world, both events and processes. S/he will be able to clearly and correctly identify the important trends that make the contemporary world and also identify the main academic theories which are used to analyse it. The student will have an understanding of how different disciplines have looked at similar situations an d will develop an appreciation for the cross-disciplinary method of research and study. The course will help the student develop a 'baseline' on which to understand the transformations wrought by information technology and start appreciating the points of change and continuity.

REMARKS: The course is designed in a way which requires active participation of the students in class discussions, assignments, and the project. Each student will be encouraged to study two topics covered in the course in some depth through extra readings and presentations.

The course will have different faculty members of the Centre for Human Sciences coming and teaching specific topics, while the overall course will be taught by Aniket Alam.

EC5.101 Networks Signals and Systems 3-1-0-4

Faculty Name: Jayanthi Sivaswamy + Anshu Sarje

COURSE TOPICS:

a. Introduce the concept of signals with time-domain, how to break-down a complex signal into smaller signals, characterization (deterministic versus random), Fourier series (summation concept), time representations versus frequency representations, why sinusoidal.

b. Transition to networks with R, L, C components their interconnections and graph. Phasor diagram, concept of lag, lead properties, sinusoidal response. Introduce impedance concept, power-energy, RL, RC, RLC, network analysis, KCL, KVL, Thevenin's theorem Millman's theorem, Norton's theorem.

c. Transient and steady-state analysis, power concepts include reactive power, introduction to power-factor correction, and then leading to concept of linearity. discussion of cases when linearity holds and when it does not apply, time invariance, one-port, two-port characterization, linear system and port relationships.

d. Transition from linearity to systems with a good example where the system is defined by the input output relationship, introduce impulse response, transfer function, and the concept of feedback.

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**20%**
Mid Sem-2 Exam	**20%**
End Sem Exam	**40%**
Assignments	**5%**
Quiz based on Assignments	**15%**

MA6.102 Probability and Random Processes 3-1-0-4

Faculty Name: Lalitha V

TYPE-WHEN: Monsoon 2020

PRE-REQUISITE : Basics of Set theory, Counting and Probability
OBJECTIVE :

COURSE TOPICS :
Sets and set operations, Probability space, Conditional probability and Bayes theorem

Discrete random variables, probability mass function, probability distribution function, example random variables and distributions;

Continuous random variables, probability density function, probability distribution function, example distributions;

Joint distributions, functions of o ne and two random variables, moments of random variables;

Conditional distribution, densities and moments, Characteristic functions, Markov, Chebyshev and Chernoff bounds.

Random sequences and modes of convergence, Strong and weak laws of large numbers, central limit theorem.

Random processes, Stationary processes, Mean and covariance functions, Ergodicity, Linear filtering of random processes, Power spectral density, Modelling of Noise.
If time permits : Markov and Poisson processes, Inference for Marko v Models.

PREFERRED TEXT BOOKS:
(Class notes are primary)

"Probability and Random Processes with applications to Signal Processing" by Henry Stark and John William Woods

"Principles of Digital Communication" by Robert Gallager

"Introduction to Probability" by Bertsekas and Tsitsiklis (available online)

***REFERENCE BOOKS:**

"Probability, Random Variables and Stochastic Processes", Papoulis and Pillai

***PROJECT: GRADING PLAN:**

Type of Evaluation	**Weightage (in %)**
Mid Sem-1 Exam	**20 %**
Mid Sem-2 Exam	**20%**
End Sem Exam	**40%**
Assignments	
Project	
Term Paper	
Other Evaluation :Quizes and class participation	**20 %**

OUTCOME: REMARKS:

MA6.101 Probability and Statistics 3-1-0-4

Faculty Name: Pawan Kumar
TYPE-WHEN: Monsoon, 2020

PRE-REQUISITE: NIL
OBJECTIVE: Understand basic concepts in probability, be able to translate models described in words to mathematical ones, getting familiar with applications of inference methods.

COURSE TOPICS :

Probability Basics:
Counting, Sets, Sample Space, Axioms of Probability, Events, Principles of Inclusion & Exclusion, Conditional Probability, Bayes Rule.

Random Variables:
Random Variables, Prob. Mass Functions, Expectation, Mean, Variance. Joint PMFs of Multiple RVs, Conditioning & Independence of RVs. Continuous RVs, Cumulative Distribution, Correlation.

Sums of RVs and Random Processes:

Markov, Chebyshev, Chernoff/Hoeffding inequalities, Law of Large Numbers, Central limit theorem, Bernoulli, Poisson Processes, Markov Chains.

Statistics:

Bayesian Inference, Hypothesis Testing, Estimation, Classical Statistics, Maximum Likelihood Estimation, Confidence Intervals.

PREFERRED TEXT BOOKS:

Introduction to Probability, 2nd Edition by Dimitri P. Bertsekas and John N. Tsitsiklis

Introduction to Probability and Statistics for Engineers and Scientists by Sheldon M. Ross.

Probabilistic Systems Analysis and Applied
Probability Online Resource. MIT OCW

https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-041sc-probabilistic- systems-analysis-and-applied-probability-fall-2013/index.htm

***REFERENCE BOOKS:**

An Introduction to Probability Theory and Its Applications,
Volume 1 by William Feller

***PROJECT:**

No

Course Assessment Plan (Monsoon 2020)

Assignments	-	35%
Quiz	-	40%
Open Book Exam/ 30 Min Quiz	-	25%

OUTCOME: Understand basic concepts in probability, be able to translate models described in words to mathematical ones, getting familiar with applications of inference methods.

REMARKS:

SC1.203 Quantum Mechanics 3-1-0-4

Faculty Name: Subhadip Mitra
TYPE-WHEN : Monsoon 2020
PRE-REQUISITES: None
OBJECTIVE: Introduce UG students to Quantum Mechanics

COURSE TOPICS:

- Introduction: The Schrödinger equation and the uncertainty principle
- Mathematical Formalism: Review of linear algebra, complex functions, Fourier transformation etc.
- The generalized statistical interpretation, Heisenberg picture
- Time independent Schrödinger equation: Infinite square well, harmonic oscillator, free particle, delta function potential, finite square well
- 3D Problems: Spherical coordinates - Hydrogen atom, angular momentum, spin
- Two particle systems, atoms
- Time independent perturbation theory
- The variational principle
- Bell's theorem

PREFERRED TEXT BOOKS:

- Introduction to Quantum Mechanics by David J Griffiths
- Molecular Quantum Mechanics by P W Atkins and R S Friedman

***REFERENCE BOOKS:**

- Principles of Quantum Mechanics by R Shankar
- Modern Quantum Mechanics by J J Sakurai
- Quantum Physics by Stephen Gasiorowicz

Course Assessment Plan (Monsoon 2020)

Assignments	-	30%
Term Paper	-	30%
Quiz	-	20%
Open Book Exam/ 30 Min Quiz	-	20%

MA4.101 Real Analysis 3-1-0-4

Faculty Name: Lakshmi Burra

TYPE-WHEN: UG-Core-Monsoon

PRE-REQUISITE:

OBJECTIVE:

COURSE TOPICS:

Sequence of real No, Bounded and Unbounded Sets, Supremum, Infimum, Limit points of a set, Closed Set, Countable and uncountable sets. Sequences, Limit points of a Sequence. Limits Inferior and Superior, Convergent sequence, Non convergent sequence, Cauchy General Principle of Convergence, bounded and monotone sequence, Infinite Series, Positive Term Series, Convergence of series of real numbers, Necessary condition, Absolute convergence and power series, Convergence tests for series.

Mean value theorems (Rolle's Theorem, Cauchy Mean Value Theorem, Lagrange's Mean Value Theorem), Indeterminate forms, Taylors Series, Partial derivatives. Integration as a limit of a sum, Some integrable functions, Fundamental theorem of Calculus, Mean Value Theorems of Integral calculus, Integration by parts, Change of variable in an integral, Second Mean value theorem, Multiple integrals,

Vector, Vector operations, Products, Areas and Determinants in 2D, Gradients, Curl and Divergence, Volumes and Determinants in space.
Analytic function of complex variable, CR Equation, Integration of a function of a complex variable, M-L inequalities. Cauchy's Integral Theorem. Cauchy's Integral formula. Taylor's and Laurent Expansion, Poles and Essential Singularities, Residues, Cauchy's residue theorem, Simple contour integrals.

Differential equations of first order and first degree. Linear ordinary differential equations of higher order with constant coefficients. Elements of Partial Differential Equation (PDE).

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Quiz-1	**5**
Quiz-2	**10**
Mid Sem Exam	**35**
End Sem Exam	**40**

Assignments	**10**
Term Paper	
Other Evaluation _____	

SC1.110 Science I 3-1-0-4

Faculty Name: Prabhakar B

Type and When: Core-Monsoon.

Course outline **#L**

First week:

1. Introduction: (visual presentation) The relevance of basic science for an IT student, a popular level presentation on symbiotic relationship between computer technology and science, the semiconductor, nanotechnology, molecular logic, keyword level ideas of quantum computing and DNA computing (without details). **1L**

2. Scales in Nature; time scales (atomic unit to the astrophysical time scales), length scales (radius of an atomic nucleus, size of a DNA, living beings on earth, to light years), energy scales (1 Hartree to fusion in the sun). Equations similar in appearance but describing processes of different scales, dimensionless numbers **1L**

Skills learnt: units and dimensions, dimensionless perception of

a problem. 2nd -3rd week:

3. Mathematical modeling in sciences,

(i) geometry and linear algebra, Geometric profiles of variable quantities (physical properties described as algebraic, trigonometric and other functions of variables like temperature, etc.), e.g., harmonic oscillator potential, Hooke's law force, etc.,

(ii) change and calculus, expression of a spatio-temporal change in terms of a differential equation, the diffusion equation, the heat conduction equation, equation of continuity, (simple conversion of natural observations into mathematical forms)

(iii) vector formulation of a multi-variable problem, coupling of variables described as matrix elements; example of symmetric and asymmetric stretching in CO_2 described as normal modes of nuclear motion. More examples on web page and assignments. **(derivations of solutions for the model problems will not be taught in this section; solutions may be provided on the course web page), 3L**

Skills: modeling of simple problems.

3rd-5th week:

4. Forms in Nature (mostly visual presentation): molecular structures, crystal lattices, biological molecules, fractals and self organized structures, basic ideas of symmetry and group theory.

Examples of linear and nonlinear structures (visual presentation), variety of nonlinear forms like trigonal, pyramidal, tetrahedral, octahedral, fullerene structures etc., cubic (simple, fcc and bcc) crystal structures, packing, etc., examples of simple fractals like Koch curve, Koch island, Peano curve, etc., fractals in Nature

2L

skills: imagining diverse forms.

6^{th} -8^{th} week:

5. Relevance of thermodynamics, - the thermodynamic space, state and path functions, work, heat, mechanical and thermal equilibrium, The macroscopic laws of thermodynamics, 0^{th} law and temperature, Work and Heat as ubiquitous components of energetics, internal energy, 1^{st} law, enthalpy, entropy principle and the concept of a potential function, free energy,the chemical potential, 2^{nd} law, applications to phase transitions and chemical equilibrium, understanding natural processes, chemical potential, coupled reactions, thermodynamics of photosynthesis, transformations as processes in an energy landscape, etc. **6L**

skills: describing natural problems in terms of energetics and spontaneity

9^{th} -11^{th} week

6. The microscopic world, the need for a reductionist approach in science, Mechanics, predictability, Newtonian and Quantum, indeterminacy in the subatomic world, the generalized coordinate, examples of forces and interaction potentials and their interrelation, the phase space, simple harmonic trajectories in phase space, anharmonicity, interaction between two atoms described in phase space, Lagrangian and Hamiltonian, geometric view of dynamical systems, angular momentum, laws of conservation.

4L

Skills: basic principles of mechanics

12^{th} – last week:

7. Failures of classical physics, Application of quantum mechanics, particle in a box problem applied to conjugated molecular systems and nano-particles, 1-D harmonic oscillator, rotation in space.

5L

7a. Harmonic oscillator and vibrational spectroscopy, Rigid rotor, H atom. (all results discussed qualitatively only - no derivations) **2L**

Books:

1. Concepts of Modern Physics by Arthur Beiser

2. Feynman Lectures in Physics, vol.I & III by R Feynman

3. Physical Chemistry by P W Atkins

4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics by F Sears

5. Heat and thermodynamics by Zeemansky

Course Assessment Plan (Monsoon 2020)

Assignments	-	30%
Project	-	10%
Any other	-	10%
Quiz	-	20%
Open Book Exam/ 30 Min Quiz	-	30%

1) Any Other = 10 for Wiki Book contribution.

EC5.201 Signal Processing 3-1-3-5

Faculty Name: Santosh Nannuru

TYPE-WHEN: Monsoon 2020

PRE-REQUISITE: Network Signals and Systems

OBJECTIVE: To develop an understanding of signal representations, digital signal processing, system analysis, and system design.

COURSE TOPICS : Fourier Transform, LTI systems, Sampling theorem, Discrete time Fourier transform (DTFT), Z-transform, analog to digital conversion, quantization, Discrete Fourier transform (DFT), Fast Fourier transform (FFT), digital filter design, FIR and IIR filter design.

Lab component: The lab component will supplement the course lectures with matlab experiments on Fourier series and Fourier transforms, sampling and interpolation, quantization, DFT, short-time Fourier transform, FIR and IIR filter design techniques.

PREFERRED TEXT BOOKS:
1. Signals and Systems by Oppenheim, Willsky and Nawab; 2nd Edition

2. Digital Signal Processing: Principles, Algorithms and Applications, John. G. Proakis and Dimitris Manolakis

***REFERENCE BOOKS:**

1. Digital Signal Processing, Alan V. Oppenheim and Ronald W. Schafer

1. Digital Signal Processing: A Computer Based Approach, Sanjit K. Mitra

GRADING PLAN: TBD

Type of Evaluation Weightage (in %)

OUTCOME: At the end of the course students should be able to represent signals in various forms, analyze their frequency content, perform sampling and interpolation of signals, process digital signals, and design digital filters with specified requirements.

Course Assessment Plan (Monsoon 2020)

Assignments	-	10%
Project	-	30%
Quiz	-	30%
Open Book Exam/ 30 Min Quiz	-	30%

Project = Lab

SC2.304 Spectroscopy(H1) 3-1-0-2

Faculty Name: Marimuthu Krishnan

TYPE-WHEN: Monsoon 2020-21
PRE-REQUISITE: None for UG3-CND students. Non-CND students interested in taking this course as an elective must have secured at least B- grade in Science-I.

OBJECTIVE: The objective of this course is to understand the basic principles and applications of different spectroscopic techniques commonly used in natural sciences.

COURSE TOPICS:

▪ Introduction: Classical mechanical description of spectroscopy, quantum mechanics and energy quantization, energy-level diagram, energy spectrum: electronic states, vibrational states, rotational states, excitation and relaxation, absorption and emission of electromagnetic waves by materials

▪ Atomic Spectra: Spectral series of hydrogen and alkali atoms,selection rules, L-S coupling, many-electron atoms, isotope shift, hyperfine splitting of spectral lines ▪ Molecular Spectra: Electronic spectrum of a diatomic molecule, Rotational spectrum of a diatomic molecule using a rigid rotator model, energy levels and spectrum of a non-rigid diatomic molecule, effect of isotopic substitution on rotational spectra, vibrational spectrum of a diatomic molecule using the harmonic and anharmonic oscillator models. Vibrational-Rotational coupling in a diatomic molecule, molecular spectra of chain molecules

▪ Raman and Infrared Spectroscopy: Classical and quantum theory of Raman effect, normal vibrations of CO 2 and H 2 O molecules, vibrational and rotational Raman spectra, basic concept of infrared spectroscopy, interpretation of Raman and IR spectra, identification of Raman-active and/or IR-active modes based on symmetry arguments
▪ Introduction to Nuclear Magnetic Resonance (NMR), and Electron Spin Resonance (ESR) spectroscopy

PREFERRED TEXTBOOKS:

1. Physical Chemistry - P. W. Atkins
2. Fundamentals of Molecular Spectroscopy - C. N. Banwell
3. Spectra of Diatomic Molecules - Herzberg
4. Atomic Spectra & Atomic Structure - Gerhard Hertzberg
5. Molecular Spectroscopy - G. M. Barrow
6. Molecules and Radiation: An Introduction to Modern Molecular Spectroscopy - J. I. Steinfeld
7. Physical Chemistry - A Molecular Approach - D. A. McQuarrie and J. D. Simon

GRADING:
Quiz - 25%
Final exam – 40%
Assignments – 35%

OUTCOME: The students will be able to apply these concepts and techniques to their research problems.

SC3.203 Systems Biology(H2) 3-1-0-2

Faculty Name: Vinod PK

TYPE-WHEN: Monsoon

FACULTY NAME: Dr. Vinod P.K.

PRE-REQUISITE: Introduction to Biology

OBJECTIVE: This course builds the foundation for understanding the principles of biological systems using mathematical modelling

COURSE TOPICS:

- Systems-level thinking, Input/output relationships
- Bottom-Up and Top-Down Approaches for Systems Biology
- Representation of biological networks
- Network organization: Motifs, modules, and hierarchical networks
- Design principles of biological systems
- Introduction to modelling in biology
- Dynamic modelling of biochemical systems
- Parameter estimation and sensitivity analysis
- Modelling transcription and signalling regulatory circuits
- Biological Switches and Clocks
- Robustness, Optimality
- Constraint-based modelling: metabolism
- Biological noise

PREFERRED TEXTBOOKS:

1. **Systems Biology: A Textbook** by Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach, Ralf Herwig, Wiley-VCH.
2. **An Introduction to Systems Biology: Design Principles of Biological Circuits** by Uri Alon, Chapman & Hall
3. **Mathematical Modelling in Systems Biology** by Brian P Ingalls, The MIT press

Course Assessment Plan (Monsoon 2020)

Assignments	-	30%
Project	-	20%
Quiz	-	30%
Open Book Exam/ 30 Min Quiz	-	20%

OUTCOME: This course will enable students to address questions on biological circuits by developing mathematical models.

EC5.202 Systems Thinking 3-1-0-4

Faculty Name: Spandan Roy + Vinod PK
TYPE-WHEN: ECE Core, Monsoon, 2nd year

PRE-REQUISITE : None
OBJECTIVE: The course aims to foster abilities to model, synthesize and control systems from a modern control theoretic standpoint with an eventual culmination in learning methods for control. Further case studies of uncommon and yet very relevant state of the art systems such as biological systems are also planned.

COURSE TOPICS:

1. Introduction to Control – Classical, State Space and pros and cons

2. Transfer functions, Conversion from State Space to Transfer Functions and Vice Versa

3. Poles and Stability of LTI systems

4. State Space Modeling of Systems

5. State Feedback/Pole Placement Control

6. State Regulator Design

6. Introduction to Model Predictive Control/ Discrete Time Optimal Control

7. Introduction to RL

8. Biological signals and systems

9. Design principles of biological systems

10. Biological feedback and control

11. Modeling and design of biological

Circuits PREFERRED TEXT BOOKS:

Digital Control and State Variable Methods, M Gopal, 4 Edition, MH Publishers Modern Control Engineering, Ogata

Biomolecular Feedback Systems, Domitilla Del Vecchio and Richard M. Murray, Princeton University Press

***REFERENCE BOOKS:**

An Introduction to Systems Biology: Design Principles of Biological Circuits, Uri Alon , Chapman & Hall.

***PROJECT: This is the first time the course is offered. We will have a better idea of projects and the need for it once we see how this goes**

Course Assessment Plan (Monsoon 2020)

Assignments	-	30%
Project	-	20%
Quiz	-	30%
Open Book Exam/ 30 Min Quiz	-	20%

OUTCOME: The student should be comfortable in looking at systems from a modern control theoretic standpoint as well as from a post modern learning standpoint. He/She should be versatile in modeling, analyzing systems and show sufficient maturity in looking at novel biological systems from such a perspective

REMARKS:

HS0.202 Thinking and Knowing in the Human Sciences – II 3-1-0-4

Faculty Name: Radhika Krishnan + Aniket Alam

PRE-REQUISITE : Admission to second year of CHD program

OBJECTIVE :

Students will be introduced to the main sociological and historiographical theories. These include the empiricist and rationalist theories, the inductive and deductive methods and the synchronic and diachronic perspectives. In history, they will deal with the various schools of history – their methods, assumptions, principles, and the foundational ideas which make the discipline. In sociology, they will briefly study key concepts like sociological imagination, structure and agency, socialisation, culture and deviation. The course intends to give students a sense of how the human world appears through the lens of these two disciplines and their insights. It would equip students to engage with academic texts as well as primary sources in a theoretically informed manner.

COURSE TOPICS :

This course is divided into two parts of 13 lectures each. The first part will focus on the discipline of History (taught by Aniket Alam) and the second part will focus on the discipline of Sociology (taught by Radhika Krishnan).

History Topics: 1. Ideas of History (Progress, Decline, Morality; Facts, Objectivity, Interpretation); 2. Concepts of Time and Space; 3. Main methods of knowing the past (Inductive and deductive methods; structuralism and post-structuralism).
Sociology Topics: 1. Sociological Concepts; 2. Key Thinkers in Sociology (Emile Durkheim, Karl Marx, Max Weber); 3. Social Institutions and Processes; 4. Sociology in India.

PREFERRED TEXT BOOKS:

1. E. H. Carr: *What is History*
2. Mircea Eliade: *The Myth of the Eternal Return*
3. Umberto Eco: *This is not the end of the book;*
4. James Scott: *Against the Grain*
5. Anthony Giddens, Philip W Sutton: *Sociology*
6. Nandini Sundar, Patricia Uberoi, Satish Deshpande: *Anthropology in the East: Founders of Indian Sociology and Anthropology*
7. D.P. Mukerji: *Basic Concepts in Sociology*

***REFERENCE BOOKS:** Some parts from other books and articles will be suggested over the course of the semester depending on the discussions in class and the varying interests of the students.

GRADING PLAN:

Type of Evaluation	Weightage (in %)
In class assignments (8)	**5% each; total 40%**

Term Paper (2)	**10% each; total 20%**
Long form essay (2)	**20% each; total 40%**

OUTCOME: At the end of this course, students will have a good grasp of the methods and foundational ideas of history and sociology. This will equip them to start accessing academic literature as well as analyse primary sources and evidence independently and drawing conclusions. The students will be able to deploy theories and methods to their own research and draw interconnections between the different ways in which the human world is understood and explained.

REMARKS: This course expects the student to read about 2000 pages of academic literature and write about 12,000 words of essays and answers over the semester.

Sd/-
Dean (Academics)