Chaitanya Bharathi Institute of Technology (Autonomous)

DEPARTMENT OF INFORMATION TECHNOLOGY

NPTEL COURSES IDENTIFIED FOR HONOURS DEGREE FOR THE PERIOD

JUL - OCT, 2023 AY: 2022-23

Syllabus of NPTEL Courses

SNo	Course Code	Course Name	Duration
1	noc23-cs100	Reinforcement Learning	12 Weeks

Course layout

Week 1 : Introduction
Week 2 : Bandit algorithms – UCB, PAC
Week 3 : Bandit algorithms –Median Elimination, Policy Gradient
Week 4 : Full RL & MDPs
Week 5 : Bellman Optimality
Week 6 : Dynamic Programming & TD Methods
Week 7 : Eligibility Traces
Week 8 : Function Approximation
Week 9 : Least Squares Methods
Week 10: Fitted Q, DQN & Policy Gradient for Full RL
Week 11: Hierarchical RL
Week 12: POMDPs

Books and references

R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. 1998.

SNo	Course Code	Course Name	Duration
2	noc23-cs100	Parameterized Algorithms	12 Weeks

Course layout

Week-1: Kernelization
Week-2: Bounded Search Trees
Week-3: Iterative Compression
Week-4: Randomized Techniques
Week-5: Treewidth - I
Week-6: Treewidth - II
Week-7: Miscellaneous Techniques: ILP and DP over subsets
Week-8: Important Separators
Week-9: Algebraic Techniques
Week-10: Cut and Count
Week-11: Matroids
Week-12: Parameterized Intractability

Books and references

Marek Cygan, Fedor V. Fomin, Lukasz Kowalik, Daniel Lokshtanov, Dániel Marx, Marcin Pilipczuk, Michal Pilipczuk, Saket Saurabh. Parameterized Algorithms. Springer-Verlag, 2015.
(Digital version freely available online.)

Optional References:

1. R.G. Downey, M. R. Fellows: Parameterized Complexity Springer-Verlag, 1999.
2. J. Flum and M. Grohe. Parameterized Complexity Theory. Springer-Verlag, 2006.
3. R. Niedermeier. Invitation to Fixed-Parameter Algorithms. Oxford University Press, 2006.
4. Daniel Lokshtanov, Meirav Zehavi, Saket Saurabh, Fedor V. Fomin. Kernelization: Theory of Parameterized Preprocessing. Cambridge University Press, 2019

SNo	Course Code	Course Name	Duration
3	**noc23-cs103**	**Getting Started With Competitive Programming**	**12 Weeks**

Course layout

Week 1: Sorting and Searching Algorithms
Week 2: Greedy Algorithms - I
Week 3: Greedy Algorithms - II
Week 4: Disjoint Set Union with Path Compression
Week 5: Minimum Spanning Tree
Week 6: Shortest Paths: Dijkstra and Beyond
Week 7: Network Flows - I
Week 8: Network Flows - II, Divide and Conquer
Week 9: Dynamic programming - I
Week 10: Dynamic programming - II
Week 11: Dynamic programming - III
Week 12: Dynamic programming – IV

Books and references

Algorithms by Jeff Erickson (freely available online)
Algorithms Illuminated by Tim Roughgarden
Algorithm Design
Jon Kleinberg and Éva Tardos
Introduction to Algorithms
Cormen, Leiserson, Rivest, Stein
Competitive Programming 4: The Lower Bound of Programming Contests in the 2020s by Steven Halim and Felix Halim
Guide to Competitive Programming: Learning and Improving Algorithms Through Contests Antti Laaksonen

SNo	Course Code	Course Name	Duration
4	**noc23-cs106**	**Social Network Analysis**	**12 Weeks**

Course layout

Week 1: Introduction ; Tutorial 1: Introduction to Python/Colab ; Tutorial 2: Introduction to NetworkX - Part I
Week 2: Network Measures ; Tutorial 3: Introduction to NetworkX - Part II
Week 3: Network Growth Models
Week 4: Link Analysis
Week 5: Tutorial 4: Graph Visualization Tools ; Community Detection - Part I
Week 6: Community Detection - Part II
Week 7: Link Prediction
Week 8: Cascade Behavior and Network Effects

Week 9: Anomaly Detection
Week 10: Introduction to Deep Learning ; Graph Representation Learning - Part I
Week 11: Graph Representation Learning - Part II ; Tutorial: Coding on Graph Representation Learning
Week 12: Applications and Case Studies ; Conclusion

Books and references

1. Social Network Analysis, Tanmoy Chakraborty, Wiley, 2021
2. Network Science, Albert-Lazzlo Barabasi
3. Social Network Analysis: Methods and Applications, Stanley Wasserman, Katherine Faus

SNo	Course Code	Course Name	Duration
5	**noc23-cs108**	**The Joy Of Computing Using python**	**12 Weeks**

Course layout

- Motivation for Computing
- Welcome to Programming!!
- Variables and Expressions : Design your own calculator
- Loops and Conditionals : Hopscotch once again
- Lists, Tuples and Conditionals : Lets go on a trip
- Abstraction Everywhere : Apps in your phone
- Counting Candies : Crowd to the rescue
- Birthday Paradox : Find your twin
- Google Translate : Speak in any Language
- Currency Converter : Count your foreign trip expenses
- Monte Hall : 3 doors and a twist
- Sorting : Arrange the books
- Searching : Find in seconds
- Substitution Cipher : What's the secret !!
- Sentiment Analysis : Analyse your Facebook data
- 20 questions game : I can read your mind
- Permutations : Jumbled Words
- Spot the similarities : Dobble game
- Count the words : Hundreds, Thousands or Millions.
- Rock, Paper and Scissor : Cheating not allowed !!
- Lie detector : No lies, only TRUTH
- Calculation of the Area : Don't measure.
- Six degrees of separation : Meet your favourites
- Image Processing : Fun with images
- Tic tac toe : Let's play
- Snakes and Ladders : Down the memory lane.
- Recursion : Tower of Hanoi
- Page Rank : How Google Works !!

Books and references

NIL

SNo	Course Code	Course Name	Duration
6	noc23-cs113	Multi-Core Computer Architecture	12 weeks

Course layout

Week 1 : Basic Computer Organization:
Review of Basic Computer Organization, Basic operational concepts, fundamental of program execution, memory and I/O addressing, Instruction set architecture- addressing modes, instruction set, instruction encoding and formats. CISC vs RISC ISA.
Week 2 : Instruction Pipeline Principles:
Performance Evaluation Methods, Introduction to RISC Instruction Pipeline, Instruction Pipeline and Performance.Pipeline Hazards and Analysis
Week 3 : Pipeline Hazards and Branch Prediction Techniques:
Pipeline Hazards Management Techniques,Branch Prediction, MIPS Pipeline for Multi-Cycle Operations.
Week 4 : Pipeline Scheduling and Speculative execution:
Compiler Techniques to Explore Instruction Level Parallelism, Dynamic Scheduling with Tomasulo's Algorithm, Speculative Execution.
Week 5 : Superscalar Processors and GPU architectures:
Advanced Pipelining, Multithreading and Hyperthreading, Superscalar Processors, GPU Architectures.
Week 6 : Cache Memory Principles
Introduction to Cache Memory, Block Replacement Techniques and Write Strategy, Design Concepts in Cache Memory.
Week 7 : Cache Memory Optimizations
Design issues for improving memory access time, Basic and Advanced Optimization Techniques in Cache Memory
Week 8 : Cache Coherence Protocols
Cache coherence and memory consistency, Snoop Based and Directory Based Cache coherence Protocols.
Week 9 : Primary Storage Systems
Introduction to DRAM System, DRAM organization, DRAM Controllers and Address Mapping.
Week 10 : Tiled Chip Multi-Core Processors & Network-on-Chip
Tiled Chip Multicore Processors (TCMP), Network on Chips (NoC), Routing Algorithms, NoC router – architecture, Routing and flow control
Week 11 : Energy Efficient NoCs
Introduction to deflection routing, Energy Efficient Buffer-less NoC Routers, Side-buffered Deflection Routers
Week 12 : Quality of Service for TCMPs
QoS of NoC and Caches in TCMPs, Emerging Trends in Network On Chips, Domain Specific Accelerators

Books and references

1. Computer Architecture - A Quantitative Approach-5e John L. Hennessy, David A. Patterson Morgan Kaufman.
2. Memory System - Cache, DRAM and Disk Bruce Jacob, Spencer W. Ng, David T. Wang Morgan Kaufman.
3. Principles and Practices of Interconnection Networks William J. Dally, Brian P. Towles Elsevier

SNo	Course Code	Course Name	Duration
7	**noc23-cs114**	**C-Based VLSI Design**	**12 weeks**

Course layout

Week-1: Introduction to Electronic Design Automation
Week-2: Introduction to C-based VLSI Design: Background
Week-3: Introduction to C-based VLSI Design: HLS Flow
Week-4: C-Based VLSI Design: Scheduling
Week-5: C-Based VLSI Design: Resource allocation and Binding, Data-path and Controller Generation
Week-6: Efficient Synthesis of C Code
Week-7: Hardware Efficient C Coding
Week-8: Impact of Compiler Optimizations in Hardware
Week-9: Verification of High-level Synthesis
Week-10: FPGA Technology Mapping
Week-11: Securing Design with High-level Synthesis
Week-12: Recent Advances in C-Based VLSI Design

Books and references

1. D. D. Gajski, N. D. Dutt, A.C.-H. Wu and S.Y.-L. Lin, High-Level Synthesis: Introduction to Chip and System Design, Springer, 1st edition, 1992
2. G. De Micheli. Synthesis and optimization of digital circuits, McGraw Hill, India Edition, 2003.
3. Mike Fingeroff, High-Level Synthesis Blue Book, Mentor Graphics Corporation, 2010.
4. Philippe Coussy and Adam Morawiec, High-level Synthesis from Algorithm to Digital Circuit, Springer, 2008
5. David. C. Ku and G. De Micheli, High-level Syntehsis of ASICs Under Timing and Synchronization Constraints, Kluwer Academic Publishers, 1992.

SNo	Course Code	Course Name	Duration
8	**noc23-cs115**	**Computer Graphics**	**8 weeks**

Course layout

Week 1: Introduction – historical evolution, issues and challenges, graphics pipeline, hardware and software basics
Week 2: Object representation – boundary representation, splines, space partitioning
Week 3: Modeling transformations – matrix representation, homogeneous coordinate system, composition, 3D transformations
Week 4: Illumination and shading – background, simple lighting model, shading models, intensity representation, color models, texture synthesis
Week 5: 3D viewing – viewing pipeline, view coordinate system, viewing transformation, projection, window-viewport transformation
Week 6: Clipping and hidden surface removal – clipping in 2D. 3D clipping algorithms, hidden surface removal

Week 7: Rendering – scan conversion of line, circle, fill-area and characters, anti-aliasing
Week 8: Graphics hardware and software – generic architecture, I/O, GPU, Shader programming, graphics software (openGL)

Books and references

1. Samit Bhattacharya. (2015). Computer Graphics. Oxford University Press.
2. Hearn, D. & Baker, M. P. (2003). Computer Graphics with OpenGL, (3rd ed), Pearson

SNo	Course Code	Course Name	Duration
9	noc23-cs116	Design & Implementation Of Human-Computer Interfaces	12 weeks

Course layout

Week 1: Introduction
Week 2: Identification of usability requirements I
Week 3: Identification of usability requirements II
Week 4: Usable interface design
Week 5: Rapid usability evaluation
Week 6: Converting design to system I
Week 7: Converting design to system II
Week 8: System implementation I
Week 9: System implementation II
Week 10:System implementation III
Week 11: Empirical usability evaluation
Week 12: Conclusion

Books and references

Samit Bhattacharya. (2019). Human-Computer Interaction: User-Centric Computing for Design, McGraw Hill Education (1st ed).
Bruce R Maxim & Roger S Pressman (2019). Software Engineering: A Practitioner's Approach. (8th ed). McGraw Hill Education.

SNo	Course Code	Course Name	Duration
10	oc23-cs118	Introduction To Computer And Network Performance Analysis Using Queuing Systems	4 weeks

Course layout

Week 1 :
1.1 Introduction, why do delays happen, contention for resources
1.2 Performance metrics and parameters
1.3 Intro to queuing system: Standard parameters and metrics, Kendall Notation. Metrics of open queuing systems
1.4 Intro to Memorylessness
1.5 Operational Laws,Utilization Law, Throughput, stability of a queuing system

Week 2 :
2.1 Asymptotic Analysis of G/G/1, G/G/1/K queues (Values of metrics at low load and high load asymptotes)
2.2 Asymptotic Analysis of G/G/c/K queues, Examples
2.3 Little's Law - Intro and discussion
2.4 Examples for Little's Law
and a Case Study of application of queing theory (open systems)
2.5 Some results for M/G/1 queues and
Memoryless arrivals
Week 3 :
3. 1 Case Study:Experimental Performance Measurement of a Web Server (open load)atch.
3.2 Open queuing networks - tandem queuing network
3.3 Open queuing networks - general jackson queuing network
3.4 Open queuing networks - examples
3.5 Closed Queuing Systems. Metrics, parameters. Analysis of simplest closed queueing system
Week 4 :
4.1 Closed Queuing System: Low Load and High Load Asymptotes of all metrics. Response Time linear asymptote, Kleinrock's Saturation Number Heuristic
4.2 Case Study:
Experimental Performance Measurement of a Web Server (closed load)
4.3 General formulation of Jacksonian Closed Queuing Networks
Arrival Theorem, Mean Value Analysis (Derivation)
4.4 Mean Value Analysis - more explanation
4.5 Mean Value Analysis examples: concluding Case Study of a Load test on a web server.
Discuss applications and limitations of queueing systems based modeling

Books and references

1. Performance Modeling and Design of Computer Systems: Queueing Theory in Action, by Mor Harchol-Balter

SNo	Course Code	Course Name	Duration
11	noc23-cs121	Problem Solving Through Programming In C	12 weeks

Course layout

Week 1 : Introduction to Problem Solving through programs, Flowcharts/Pseudo codes, the compilation process, Syntax and Semantic errors, Variables and Data Types
Week 2 : Arithmetic expressions, Relational Operations, Logical expressions; Introduction to Conditional Branching
Week 3 : Conditional Branching and Iterative Loops
Week 4 : Arranging things : Arrays
Week 5 : 2-D arrays, Character Arrays and Strings
Week 6 : Basic Algorithms including Numerical Algorithms
Week 7 : Functions and Parameter Passing by Value
Week 8 : Passing Arrays to Functions, Call by Reference
Week 9 : Recursion
Week 10 : Structures and Pointers
Week 11 : Self-Referential Structures and Introduction to Lists
Week 12 : Advanced Topics

Books and references
Textbooks:
1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
Reference Books:
1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

SNo	Course Code	Course Name	Duration
12	**noc23-cs124**	**Demystifying Networking**	**4 Weeks**

Course layout

Week 1: Layers of Computer Networks and Network Addressing
Week 2: Routing
Week 3: Transport and Application Layers
Week 4: Introduction to Security and Troubleshooting

Books and references
There are many textbooks on computer networking. Students may refer to any of them for the topics in this course

SNo	Course Code	Course Name	Duration
13	**noc23-cs66**	**Software Conceptual Design**	**4 Weeks**

Course layout

Week 1: Deconstructing the software design process
Week 2: Designing Software using the FBS Framework
Week 3: Comprehending and Evaluating Software Designs
Week 4: The Next Steps - Where does one go from here

Books and references
1 .Software Engineering: A Precise Approach – Dr. Pankaj Jalote.
2. Cooperative Software Development – Dr. Amy Ko.

SNo	Course Code	Course Name	Duration
14	**noc23-cs67**	**Computer Architecture**	**12 Weeks**

Course layout

Week 1 : Introduction to Computing
Week 2 : Number Systems
Week 3 : Floating Point Numbers
Week 4 : Assembly Language – I
Week 5 : Assembly Language – II
Week 6 : Algorithms for Binary Addition

Week 7 : Algorithms for Multiplication and Division
Week 8 : Processor Design
Week 9 : Pipelining – I
Week10 : Pipelining – II
Week 11 : Memory Systems – Caches
Week 12 : Virtual Memory

Books and references
Computer Organisation and Architecture, Smruti R. Sarangi, McGrawHill (2015)

SNo	Course Code	Course Name	Duration
15	**noc23-cs68**	**Advanced Distributed Systems**	**12 Weeks**

Course layout

Week 1 : Epidemic and gossip based algorithms
Week 2 : Napster and Gnutella
Week 3 : DHTs: Chord, Pastry and BitTorrent
Week 4 : Logical clocks, Mutual Exclusion Algorithms
Week 5 : Distributed Leader Election
Week 6 : Distributed minimum spanning tree, the FLP result
Week 7 : Consistency models and the CAP theorem
Week 8 : Paxos and Raft
Week 9 : Byzantine General's Problem, Virtual synchrony
Week 10 : Bitcoin and Blockchains
Week 11 : Amazon Dynamo, Facebook Cassandra, Google Percolator
Week 12 : Voldemort (LinkedIn), Condor, and Microsoft DryadLINQ

Books and references
Classic research papers.

SNo	Course Code	Course Name	Duration
16	**noc23-cs69**	**Privacy And Security In Online Social Media**	**12 Weeks**

Course layout

Week 1: What is Online Social Networks, data collection from social networks, challenges, opportunities, and pitfalls in online social networks, APIs
Week 2: Collecting data from Online Social Media.
Week 3: Trust, credibility, and reputations in social systems
Week 4: Trust, credibility, and reputations in social systems
Week 5: Online social Media and Policing
Week 6: Information privacy disclosure, revelation and its effects in OSM and online social networks
Week 7: Phishing in OSM & Identifying fraudulent entities in online social networks
Week 8: Refresher for all topics
Week 9 to 12: Research paper discussionNil

SNo	Course Code	Course Name	Duration
17	**noc23-cs75**	**Ethical Hacking**	**12 Weeks**

Course layout

Week 1: Introduction to ethical hacking. Fundamentals of computer networking. TCP/IP protocol stack.
Week 2: IP addressing and routing. TCP and UDP. IP subnets.
Week 3: Routing protocols. IP version 6.
Week 4: Installation of attacker and victim system. Information gathering using advanced google search,
archive.org, netcraft, whois, host, dig, dnsenum and NMAP tool.
Week 5: Vulnerability scanning using NMAP and Nessus. Creating a secure hacking environment.
System Hacking: password cracking, privilege escalation, application execution. Malware and
Virus. ARP spoofing and MAC attack.
Week 6: Introduction to cryptography, private-key encryption, public-key encryption.
Week 7: Cryptographic hash functions, digital signature and certificate, applications.
Week 8: Steganography, biometric authentication, network-based attacks, DNS and Email security.
Week 9: Packet sniffing using wireshark and burpsuite, password attack using burp suite.
Social engineering attacks and Denial of service attacks.
Week 10: Elements of hardware security: side-channel attacks, physical inclinable functions, hardware
trojans.
Week 11: Different types of attacks using Metasploit framework: password cracking, privilege escalation,
remote code execution, etc.Attack on web servers: password attack, SQL injection, cross site
scripting.
Week 12: Case studies: various attacks scenarios and their remedies.

Books and references

Data and Computer Communications -- W. Stallings.
Data Communication and Networking -- B. A. Forouzan
TCP/IP Protocol Suite -- B. A. Forouzan
UNIX Network Programming -- W. R. Stallings
Introduction to Computer Networks and Cybersecurity -- C-H. Wu and J. D. Irwin
Cryptography and Network Security: Principles and Practice -- W. Stallings
** Various web resources **

SNo	Course Code	Course Name	Duration
18	**noc23-cs76**	**Hardware Modeling Using Verilog**	**8 Weeks**

Course layout

Week 1: Introduction to digital circuit design flow (3 hours)
Week 2: Verilog variables, operators and language constructs (2 hours)
Week 3: Modeling combinational circuits using Verilog (2 hours)
Week 4: Modeling sequential circuits using Verilog (3 hours)
Week 5: Verilog test benches and design simulation (2 hours)
Week 6: Behavioral versus structural design modeling (2 hours)
Week 7: Miscellaneous modeling issues: pipelining, memory, etc. (2 hours)
Week 8: Processor design using Verilog (4 hours)

Books and references
Nil

SNo	Course Code	Course Name	Duration
19	**noc23-cs78**	**Programming In Modern C++**	**12 Weeks**

Course layout

Week 1: Programming in C++ is Fun.
Week 2: C++ as Better C.
Week 3: OOP in C++.
Week 4: OOP in C++.
Week 5: Inheritance.
Week 6: Polymorphism.
Week 7: Type Casting.
Week 8: Exceptions and Templates.
Week 9: Streams and STL.
Week 10: Modern C++.
Week 11: Lambda and Concurrency.
Week 12: Move, Rvalue and STL Containers.

Books and references
Online Material:
C++ reference - C++98 and C++03, C++11, C++14.
Overview of the New C++ (C++11/14) by Scott Meyers, 2015.
ISO C++ Standards.
Presentations used in the Course.
Books:
C++ Move Semantics - The Complete Guide by Nicolai M. Josuttis, 2020.
C++ Concurrency in Action, 2nd Edition by Anthony Williams, 2019.
C++17 - The Complete Guide by Nicolai M. Josuttis, 2020.
C++17 In Detail: Learn the Exciting Features of The New C++ Standard! by Bartlomiej Filipek, 2019.
Professional C++, 4th Edition by Marc Gregoire, 2018.
Functional Programming in C++ by Ivan Čukić, 2018.
Effective Modern C++: 42 Specific Ways to Improve Your Use of C++11 and C++14 by Scott Meyers, 2015.

SNo	Course Code	Course Name	Duration
20	noc23-cs80	Natural Language Processing	12 Weeks

Course layout

Week 1: Introduction and Basic Text Processing
Week 2: Spelling Correction, Language Modeling
Week 3: Advanced smoothing for language modeling, POS tagging
Week 4: Models for Sequential tagging – MaxEnt, CRF
Week 5: Syntax – Constituency Parsing
Week 6: Dependency Parsing
Week 7: Distributional Semantics
Week 8: Lexical Semantics
Week 9: Topic Models
Week 10: Entity Linking, Information Extraction
Week 11: Text Summarization, Text Classification
Week 12: Sentiment Analysis and Opinion Mining

Books and references

1. Dan Jurafsky and James Martin. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition. Prentice Hall, Second Edition, 2009.
Some draft chapters of the third edition are available online: https://web.stanford.edu/~jurafsky/slp3/
2. Chris Manning and Hinrich Schütze. Foundations of Statistical Natural Language Processing. MIT Press, Cambridge, MA: May 1999.

SNo	Course Code	Course Name	Duration
21	noc23-cs84	Statistical Learning For Reliability Analysis	12 Weeks

Course layout

Week 1: Introduction to reliability, reliability estimation, concept of statistical learning, advanced techniques to reliability analysis.
Week 2: Probability distribution techniques: discrete and continuous probability distributions and their applications to reliability estimation modeling.
Week 3: Sampling distribution techniques and their different applications for reliability prediction.
Week 4: Statistical inference technique-I (Parametric-based approaches: Hypothesis testing, Confidence interval estimation).
Week 5: Case studies for reliability analysis with parametric-based approaches.
Week 6: Statistical inference techniques-II (Non-parametric-based approaches: Correlation analysis, Relation analysis, Regression analysis).
Week 7: Case studies for reliability analysis with non-parametricbased approaches
Week 8: Statistical learning with single population, pair t-tests techniques. Illustration with applications to reliability analysis.
Week 9: Statistical learning with more than one population, ANOVA techniques. Illustration with applications to reliability analysis.
Week 10: Maximum likelihood estimation techniques. Illustration with applications to reliability analysis.

Week 11: Statistical method of data classification. Illustration with applications to reliability analysis.
Week 12: Entropy and its applications to statistical learning. Illustration with applications to reliability analysis.

Books and references

An Introduction to Statistical Learning: with Applications in R, G James, D. Witten, T Hastie, and R. Tibshirani, (Springer)
Software for Data Analysis: Programming with R (Statistics and Computing), John M. Chambers (Springer)
Advances in Complex Data Modeling and Computational Methods in Statistics, Anna Maria Paganoni and Piercesare Secchi, (Springer)

SNo	Course Code	Course Name	Duration
22	**noc23-cs86**	**Machine Learning For Earth System Sciences**	**8 Weeks**

Course layout

Week 1: Recap of probability, spatio-temporal statistics (autoregression, geostatistical equation, Gaussian Processes, Extreme value statistics)
Week 2: Recap of relevant Machine Learning and Deep Learning techniques (Bayesian Networks, CNN, RNN/LSTM, VaE, Interpretability, Causality)
Week 3: Earth System Process Understanding: case studies (predictors of monsoon, extreme weather forecasting, climate change visualization)
Week 4: Earth System Process Understanding: case studies(Extreme event analysis, networks and teleconnections, causal analysis)
Week 5: Earth System Process Understanding: case studies(Extreme event analysis, networks and teleconnections, causal analysis)
Week 6: Earth System Process Understanding: case studies(Extreme event analysis, networks and teleconnections, causal analysis)
Week 7: Earth System Modeling: relevant concepts (Model structures, modeling challenges, model validation, data assimilation)
Week 8: Earth System Modeling: applications in different domains (ML-based surrogate models, deep and shallow generators, long-term forecasting)

Books and references

Handbook of Spatial Statistics, Edited By Alan E. Gelfand, Peter Diggle, Peter Guttorp, Montserrat Fuentes, CRC Press, 2010
Deep Learning for the Earth Sciences, Edited by Gustau Camps-Valls, Devis Tuia, Xiao Xiang Zhu, Markus Reichstein

SNo	Course Code	Course Name	Duration
23	**noc23-cs90**	**Google Cloud Computing Foundations**	**8 Weeks**

Course layout

Week 0 : Introduction to the course
Week 1: So, What's the Cloud anyway? Start with a Solid Platform
Week 2 : Use GCP to build your Apps
Week 3: Where do I store this stuff?
Week 4: There's an API for that! You can't secure the Cloud right?
Week 5: It helps to network!
Week 6 : It helps to network (continued)
Week 7: Let Google keep an eye on things. You have the data, but what are you doing with it?
Week 8 : Let machines do the work

Books and references
https://cloud.google.com/docs/
https://www.qwiklabs**.com/**

SNo	Course Code	Course Name	Duration
24	**noc23-cs91**	**Software Testing (IIITB)**	**12 Weeks**

Course layout

Week 1: Techniques and algorithms for test case design: Graphs based testing-structural coverage criteria.
Week 2: Graphs based testing: Data flow coverage criteria
Week 3: Graphs based testing: Data flow coverage criteria
Week 4: Graphs coverage for source code, design elements and requirements
Week 5: Techniques and algorithms for test case design: Logic based testing-Predicates, logic based coverage criteria
Week 6: Specification based logic coverage, logic coverage on finite state machines
Week 7: Input space partitioning: Input domain modeling, combination strategies criteria
Week 8: Syntax based testing: Coverage criteria based on syntax, mutation testing
Week 9: Test case design (as learnt above) applied to object-oriented applications
Week 10: Test case design (as learnt above) applied to web applications
Week 11: Symbolic testing
Week 12: Concolic testing, Conclusion

Books and references
Nil

SNo	Course Code	Course Name	Duration
25	noc23-cs92	Artificial Intelligence : Search Methods For Problem Solving	12 Weeks

Course layout

Week 0 : Introduction: History, Can Machines think?, Turing Test, Winograd Schema Challenge, Language and Thought, Wheels & Gears
Week 1 : Introduction: Philosophy, Mind, Reasoning, Computation, Dartmouth Conference, The Chess Saga, Epiphenomena
Week 2 : State Space Search: Depth First Search, Breadth First Search, Depth First Iterative Deepening
Week 3 : Heuristic Search: Best First Search, Hill Climbing, Solution Space, TSP, Escaping Local Optima, Stochastic Local Search
Week 4 : Population Based Methods: Genetic Algorithms, SAT, TSP, emergent Systems, Ant Colony Optimization
Week 5 : Finding Optimal Paths: Branch & Bound, A*, Admissibility of A*, Informed Heuristic Functions
Week 6 : Space Saving Versions of A*: Weighted A*, IDA*, RBFS, Monotone Condition, Sequence Alignment, DCFS, SMGS, Beam Stack Search
Week 7 : Game Playing: Game Theory, Board Games and Game Trees, Algorithm Minimax, AlphaBeta and SSS*
Week 8 : Automated Planning: Domain Independent Planning, Blocks World, Forward &Backward Search, Goal Stack Planning, Plan Space Planning
Week 9 : Problem Decomposition: Means Ends Analysis, Algorithm Graphplan, Algorithm AO*
Week 10 : Rule Based Expert Systems: Production Systems, Inference Engine, Match-Resolve-Execute, Rete Net
Week 11 : Deduction as Search: Logic, Soundness, Completeness, First Order Logic, Forward Chaining, Backward Chaining
Week 12 : Constraint Processing: CSPs, Consistency Based Diagnosis, Algorithm Backtracking, Arc Consistency, Algorithm Forward Checking

Books and references

Text Book:

1. Deepak Khemani. A First Course in Artificial Intelligence, McGraw Hill Education (India), 2013.

Reference Books:

1. Stefan Edelkamp and Stefan Schroedl. Heuristic Search: Theory and Applications, Morgan Kaufmann, 2011.
2. John Haugeland, Artificial Intelligence: The Very Idea, A Bradford Book, The MIT Press, 1985.
3. Pamela McCorduck, Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence, A K Peters/CRC Press; 2 edition, 2004.
4. Zbigniew Michalewicz and David B. Fogel. How to Solve It: Modern Heuristics. Springer; 2nd edition, 2004.
5. Judea Pearl. Heuristics: Intelligent Search Strategies for Computer Problem Solving, Addison-Wesley, 1984.
6. Elaine Rich and Kevin Knight. Artificial Intelligence, Tata McGraw Hill, 1991.
7. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall, 2009.

8. Eugene Charniak, Drew McDermott. Introduction to Artificial Intelligence, Addison-Wesley, 1985.
9. Patrick Henry Winston. Artificial Intelligence, Addison-Wesley, 1992.

SNo	Course Code	Course Name	Duration
26	noc23-cs94	Introduction To Haskell Programming	8 Weeks

Course layout

Week 1: Introduction to Haskell and the ghci interpreter
Week 2: Defining functions: guards, pattern matching and recursion
Week 3: Lists, strings and tuples
Week 4: Types and polymorphim
Week 5: Higher order functions on lists: map, filter, list comprehension
Week 6: Computation as rewriting, lazy evaluation and infinite data structures
Week 7: Conditional polymorphism and type classes
Week 8: User defined datatypes: lists, queues, trees
Week 9: Input/output and the ghc compiler
Week 10: Arrays

Books and references

Nil

SNo	Course Code	Course Name	Duration
27	noc23-cs99	Python For Data Science	4 Weeks

Course layout

Week 1:
BASICS OF PYTHON SPYDER (TOOL)
- Introduction Spyder
- Setting working Directory
- Creating and saving a script file
- File execution, clearing console, removing variables from environment, clearing environment
- Commenting script files
- Variable creation
- Arithmetic and logical operators
- Data types and associated operations

Week 2:
Sequence data types and associated operations
- Strings
- Lists
- Arrays
- Tuples
- Dictionary
- Sets
- Range

NumPy
• ndArray
Week 3:
Pandas dataframe and dataframe related operations on Toyota Corolla dataset
Reading files
Exploratory data analysis
Data preparation and preprocessing
Data visualization on Toyoto Corolla dataset using matplotlib and seaborn libraries
Scatter plot
Line plot
Bar plot
Histogram
Box plot
Pair plot
Control structures using Toyota Corolla dataset
if-else family
for loop
for loop with if break
while loop
Functions

Week 4: CASE STUDY

Regression
Predicting price of pre-owned cars
Classification
Classifying personal income
Books and references
1. Introduction to linear algebra - by Gilbert Strang
2. Applied statistics and probability for engineers – by Douglas Montgomery
3. Mastering python for data science, Samir Madhavan

SNo	Course Code	Course Name	Duration
28	**noc23-cs126**	**Deep Learning for Computer Vision**	**12 Weeks**

Course layout

Week 1: Introduction and Overview:
● Course Overview and Motivation; History of Computer Vision; Image Representation; Linear Filtering, Correlation, Convolution; Image in Frequency Domain
● (Optional) Image Formation; Image Sampling
Week 2: Visual Features and Representations:
● Edge Detection; From Edges to Blobs and Corners; Scale Space, Image Pyramids and Filter Bank; SIFT and Variants; Other Feature Spaces
● (Optional) Image Segmentation, Human Visual System
Week 3: Visual Matching:

● Feature Matching; From Points to Images: Bag-of-Words and VLAD Representations; Image Descriptor Matching; From Traditional Vision to Deep Learning
● (Optional) Hough Transform; Pyramid Matching
Week 4: Deep Learning Review:
● Neural Networks: A Review; Feedforward Neural Networks and Backpropagation; Gradient Descent and Variants; Regularization in Neural Networks; Improving Training of Neural Networks
Week 5: Convolutional Neural Networks (CNNs):
● Convolutional Neural Networks: An Introduction; Backpropagation in CNNs; Evolution of CNN Architectures for Image Classification; Recent CNN Architectures; Finetuning in CNNs
Week 6: Visualization and Understanding CNNs:
● Explaining CNNs: Visualization Methods; Early Methods (Visualization of Kernels; Backprop-to-image/Deconvolution Methods); Class Attribution Map Methods (CAM,Grad-CAM, Grad-CAM++, etc); Going Beyond Explaining CNNs
● (Optional) Explaining CNNs: Recent Methods
Week 7: CNNs for Recognition, Verification, Detection, Segmentation:
● CNNs for Object Detection; CNNs for Segmentation; CNNs for Human Understanding: Faces
● (Optional) CNNs for Human Understanding: Human Pose and Crowd; CNNs for Other Image Tasks
Week 8: Recurrent Neural Networks (RNNs):
● Recurrent Neural Networks: Introduction; Backpropagation in RNNs; LSTMs and GRUs; Video Understanding using CNNs and RNNs
Week 9: Attention Models:
● Attention in Vision Models: An Introduction; Vision and Language: Image Captioning; Self-Attention and Transformers
● (Optional) Beyond Captioning: Visual QA, Visual Dialog; Other Attention Models
Week 10: Deep Generative Models:
● Deep Generative Models: An Introduction; Generative Adversarial Networks; Variational Autoencoders; Combining VAEs and GANs
● (Optional) Beyond VAEs and GANs: Other Deep Generative Models
Week 11: Variants and Applications of Generative Models in Vision:
● GAN Improvements; Deep Generative Models across Multiple Domains; Deep Generative Models: Image Application
● (Optional) VAEs and Disentanglement; Deep Generative Models: Video Applications
Week 12:Recent Trends:
● Few-shot and Zero-shot Learning; Self-Supervised Learning; Adversarial Robustness; Course Conclusion
● (Optional) Pruning and Model Compression; Neural Architecture Search

Books and references

Deep learning is a rapidly evolving field, and we will hence use multiple sources of references, including books, blogs and articles, each of which will be pointed out at the end of each topic.
References for deep learning:
● Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, 2016
● Michael Nielsen, Neural Networks and Deep Learning, 2016
● Yoshua Bengio, Learning Deep Architectures for AI, 2009
References for computer vision:

- Richard Szeliski, Computer Vision: Algorithms and Applications, 2010.
- Simon Prince, Computer Vision: Models, Learning, and Inference, 2012.
- David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, 2002.

Tools

We will use PyTorch for our assignments.

Other useful references:

- Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995. ISBN: 9780198538646.
- Bishop, Christopher M. Pattern Recognition and Machine Learning. Springer, 2006. ISBN 978-0-387-31073-2
- Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000. ISBN: 9780471056690.
- Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
- Richard Hartley, Andrew Zisserman, Multiple View Geometry in Computer Vision, 2004.
- David Marr, Vision, 1982.