University of Engineering & Management, Kolkata

Department of Computer Science and Technology (CST)

&

Department of Computer Science and Information Technology (CSIT)

1. **Program Outcomes**
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List of Program Outcomes (POs) for CST & CSIT Departments are given below.

PO NUMBER	SUMMARY	DESCRIPTION
PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals and specialization to solve complex problems.
PO2	**Problem analysis**	Identify, formulate, research literature, and analyze complex engineering problems reaching significant conclusion using principal of mathematics, natural science and engineering principles.
PO3	**Design /development of solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**	Conduct extensive research and use research outcomes including designs of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
PO5	**Modern tool usage**	Create, select, and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering values activities with an understanding of the limitation.
PO6	**The engineer and society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7	**Environment and sustainability**	Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**	Work as an individual, and as a member or leader in multidisciplinary teams.
P010	**Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
P011	**Project management and finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team,
P012	**Life-long learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

List of Program Specific Outcomes (PSOs)

PSO Number	Description
PSO 1	Ability to understand the principles and development methodologies of computer systems. Students can assess the hardware of computer systems and possess professional skills and knowledge of the software design process.
PSO 2	Ability to apply mathematical methodologies to solve computation task, model real world problem using appropriate data structure and suitable algorithm.
PSO 3	Ability to use knowledge in various domains to identify research gaps and hence to provide solutions to new ideas and innovations.

List of Program Educational Objectives (PEOs)

PEO 01: High Quality Engineering Design and Development Work:

Graduates of the program will engage in the effective practice of computer science and information technology to identify and solve important problems in a diverse range of application areas.

PEO 02: Real Life Problem Solving:

To educate students with proficiency in core areas of computer science & information technology and related engineering so as to comprehend engineering trade-offs, analyze, design, and synthesize data and technical concepts to create novel products and solutions for the real life problems.

PEO 03: Leadership:

Graduates of the program will engage in successful careers in industry, academia and attain positions of importance where they have impact on their business, profession and community.

PEO 04: Lifelong Learning:

Graduates of the program will adapt to contemporary technologies, tools and methodologies to remain at the frontier of computer science and information technology practice with the ability to respond to the need of a challenging environment.

Program Outcomes – Competencies – Performance Indicators

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.	
Competency	**Indicators**
1.1 Demonstrate competence in mathematical modelling	1.1.1 Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems 1.1.2 Apply the concepts of probability, statistics and queuing theory in modeling of computer-based system, data and network protocols.
1.2 Demonstrate competence in basic sciences	1.2.1 Apply laws of natural science to an engineering problem
1.3 Demonstrate competence in engineering fundamentals	1.3.1 Apply engineering fundamental knowledge.
1.4 Demonstrate competence in specialized engineering knowledge to the program	1.4.1 Implement the theories and principles of computer science and information technology to solve an engineering problem
PO 2: Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	
Competency	**Indicators**
2.1 Demonstrate an ability to identify and formulate complex engineering problem	2.1.1 Evaluate problem statements and identifies objectives 2.1.2 Identify processes/modules/algorithms of a computer-based system and parameters to solve a problem 2.1.3 Identify mathematical algorithmic knowledge that applies to a given problem
2.2 Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.1 Reframe the computer-based system into interconnected subsystems 2.2.2 Identify functionalities and computing resources. 2.2.3 Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions

	2.2.4 Compare and contrast alternative solution/methods to select best methods 2.2.5 Select the best process among a probable list of solutions.
2.3 Demonstrate an ability to formulate and interpret a model	2.3.1 Able to apply computer engineering principles to formulate modules of a system with required applicability and performance. 2.3.2 Identify design constraints for required performance criteria.
2.4 Demonstrate an ability to execute a solution process and analyze results	2.4.1 Applies engineering mathematics to implement the solution. 2.4.2 Analyze and interpret the results using contemporary tools. 2.4.3 Identify the limitations of the solution and sources/causes. 2.4.4 Arrive at conclusions with respect to the objectives.
PO 3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.	
3.1 Demonstrate an ability to define a complex/ open-ended problem in engineering terms	3.1.1 Able to define a precise problem statement with objectives and scope. 3.1.2 Able to identify and document system requirements from stake- holders. 3.1.3 Able to review state-of-the-art literature to synthesize system requirements. 3.1.4 Able to choose appropriate quality attributes as defined by ISO/IEC/IEEE standard. 3.1.5 Explore and synthesize system requirements from larger social and professional concerns. 3.1.6 Able to develop software requirement specifications (SRS).
3.2 Demonstrate an ability to generate a diverse set of alternative design solutions	3.2.1 Able to explore design alternatives. 3.2.2 Able to produce a variety of potential design solutions suited to meet functional requirements. 3.2.3 Identify suitable non-functional requirements for evaluation of alternate design solutions.
3.3 Demonstrate an ability to select optimal design scheme for further development	3.3.1 Able to perform systematic evaluation of the degree to which several design concepts meet the criteria. 3.3.2 Consult with domain experts and stakeholders to select candidate engineering design solution for further development

3.4 Demonstrate an ability to advance an engineering design to defined end state	3.4.1 Able to refine architecture design into a detailed design within the existing constraints. 3.4.2 Able to implement and integrate the modules. 3.4.3 Able to verify the functionalities and validate the design.
PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	
4.1 Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	4.1.1 Define a problem for purposes of investigation, its scope and importance 4.1.2 Able to select appropriate procedure/algorithm, dataset and test cases. 4.1.3 Able to select appropriate hardware/software tools to conduct the experiment.
4.2 Demonstrate an ability to design experiments to solve open-ended problems	4.2.1 Design and develop appropriate procedures/methodologies based on the study objectives
4.3 Demonstrate an ability to analyze data and reach a valid conclusion	4.3.1 Use appropriate procedures, tools and techniques to collect and analyze data 4.3.2 Critically analyze data for trends and correlations, stating possible errors and limitations 4.3.3 Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions 4.3.4 Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions
PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	
5.1 Demonstrate an ability to identify/create modern engineering tools, techniques and resources	5.1.1 Identify modern engineering tools, techniques and resources for engineering activities 5.1.2 Create/adapt/modify/extend tools and techniques to solve engineering problems

5.2 Demonstrate an ability to select and apply discipline-specific tools, techniques and resources	5.2.1 Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs. 5.2.2 Demonstrate proficiency in using discipline-specific tools
5.3 Demonstrate an ability to evaluate the suitability and limitations of tools used to solve an engineering problem	5.3.1 Discuss limitations and validate tools, techniques and resources 5.3.2 Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.
PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	
6.1 Demonstrate an ability to describe engineering roles in a broader context, e.g. pertaining to the environment, health, safety, legal and public welfare	6.1.1 Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level
6.2 Demonstrate an understanding of professional engineering regulations, legislation and standards	6.2.1 Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.	
7.1 Demonstrate an understanding of the impact of engineering and industrial practices	7.1.1 Identify risks/impacts in the life-cycle of an engineering product or activity 7.1.2 Understand the relationship between the technical, socio- economic and environmental dimensions of sustainability

on social, environmental and in economic contexts	
7.2 Demonstrate an ability to apply principles of sustainable design and development	7.2.1 Describe management techniques for sustainable development 7.2.2 Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	
8.1 Demonstrate an ability to recognize ethical dilemmas	8.1.1 Identify situations of unethical professional conduct and propose ethical alternatives
8.2 Demonstrate an ability to apply the Code of Ethics	8.2.1 Identify tenets of the ASME professional code of ethics 8.2.2 Examine and apply moral & ethical principles to known case studies
PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	
9.1 Demonstrate an ability to form a team and define a role for each member	9.1.1 Recognize a variety of working and learning preferences; appreciate the value of diversity on a team 9.1.2 Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
9.2 Demonstrate effective individual and team operations--communication, problem- solving, conflict resolution and leadership skills	9.2.1 Demonstrate effective communication, problem-solving, conflict resolution and leadership skills 9.2.2 Treat other team members respectfully Listen to other members 9.2.3 Maintain composure in difficult situations
9.3 Demonstrate success in a team-based project	9.3.1 Present results as a team, with smooth integration of contributions from all individual efforts

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	
10.1 Demonstrate an ability to comprehend technical literature and document project work	10.1.1 Read, understand and interpret technical and non-technical information 10.1.2 Produce clear, well-constructed, and well-supported written engineering documents 10.1.3 Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
10.2 Demonstrate competence in listening, speaking, and presentation	10.2.1 Listen to and comprehend information, instructions, and viewpoints of others 10.2.2 Deliver effective oral presentations to technical and non-technical audiences
10.3 Demonstrate the ability to integrate different modes of communication	10.3.1 Create engineering-standard figures, reports and drawings to complement writing and presentations 10.3.2 Use a variety of media effectively to convey a message in a document or a presentation
PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	
11.1 Demonstrate an ability to evaluate the economic and financial performance of an engineering activity	11.1.1 Describe various economic and financial costs/benefits of an engineering activity 11.1.2 Analyze different forms of financial statements to evaluate the financial status of an engineering project
11.2 Demonstrate an ability to compare and contrast the costs/benefits of alternate proposals for an engineering activity	11.2.1 Analyze and select the most appropriate proposal based on economic and financial considerations.

11.3 Demonstrate an ability to plan/manage an engineering activity within time and budget constraints	11.3.1 Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks. 11.3.2 Use project management tools to schedule an engineering project, so it is completed on time and on budget.
PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to Engage in independent and life-long learning in the broadest context of technological change.	
12.1 Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps	12.1.1 Describe the rationale for the requirement for continuing professional development 12.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
12.2 Demonstrate an ability to identify changing trends in engineering knowledge and practice	12.2.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current 12.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field
12.3 Demonstrate an ability to identify and access sources for new information	12.3.1 Source and comprehend technical literature and other credible sources of information 12.3.2 Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

CST & CSIT
COURSE STRUCTURE

Semester : 3							
Sr. No	**Type of Course**	**Course Code**	**Course Title**	**Hours per week**			
				Lecture	**Tutorial**	**Practical**	**Credits**
1	Engineering Science Course	ESC301	Analog Electronic Circuits	3	0	0	**3**
2	Engineering Science Course	ESC391	Analog Electronic Circuits Laboratory	0	0	4	**2**
3	Professional Core Courses	PCC-CS301	Data Structure & Algorithms	3	0	0	**3**
4	Professional Core Courses	PCC-CS391	Data Structure & Algorithms Laboratory	0	0	4	**2**
5	Engineering Science Course	ESC302	Digital Electronics	3	0	0	**3**
6	Engineering Science Course	ESC392	Digital Electronics Laboratory	0	0	4	**2**
7	Professional Core Courses	PCC-CS302	IT Workshop (Sci Lab/MATLAB/Python/R)	1	0	0	**1**
8	Professional Core Courses	PCC-CS392	IT Workshop Practical (Sci Lab/MATLAB/Python/R)	0	0	4	**2**
9	Basic Science Course	BSC301	Mathematics-III (Differential Calculus, Probability, Statistics)	2	0	0	**2**
10	Humanities and social sciences including Management Courses	HSMC301	Humanities – I (Technical Report Writing using Latex)	3	0	0	**3**
11	Humanities and social sciences including Management Courses	HSMC302	Universal Human Values - III	3	0	0	**3**
12	Mandatory Additional Requirements (MAR)	MC381	Mandatory Additional Requirements (MAR)	0	0	0	**0**
13	Project	PROJ-CS301	Innovative Project - I	0	0	0	**1**
14	MOOCs (Mandatory for Honours)	MOOC 3	Massive Open Online Course (Mandatory for B.Tech(Honours))	0	0	0	**1**
Total Credit Points of Semester [for B.Tech]				**18**	**0**	**16**	**27**
Total Credit Points of Semester [for B.Tech (Hons.)]							**28**

Semester : 4							
Sr. No	**Type of Course**	**Course Code**	**Course Title**	**Hours per week**			
				Lecture	**Tutorial**	**Practical**	**Credits**
1	Professional Core Courses	PCC-CS401	Discrete Mathematics	3	1	0	**4**
2	Professional Core Courses	PCC-CS402	Computer Organization & Architecture	3	0	0	**3**
3	Professional Core Courses	PCC-CS492	Computer Organization & Architecture Laboratory	0	0	4	**2**
4	Professional Core Courses	PCC-CS403	Operating Systems	3	0	0	**3**
5	Professional Core Courses	PCC-CS493	Operating Systems Laboratory	0	0	4	**2**
6	Professional Core Courses	PCC-CS404	Design & Analysis of Algorithms	3	0	0	**3**
7	Professional Core Courses	PCC-CS494	Design & Analysis of Algorithms Laboratory	0	0	4	**2**
8	Professional Core Course	PCC-CS405	Artificial Intelligence & Machine Learning	2	0	0	**2**
9	Professional Core Course	PCC-CS495	Artificial Intelligence & Machine Learning Laboratory	0	0	2	**1**
10	Humanities and social sciences including Management Courses	HSMC401	Management - I (Finance & Accounting)	3	0	0	**3**
11	Humanities and social sciences including Management Courses	HSMC402	Universal Human Values – IV	3	0	0	**3**
12	Mandatory Courses	MC401	Environmental Sciences	0	0	0	**0**
13	Mandatory Additional Requirements (MAR)	MC481	Mandatory Additional Requirements (MAR)	0	0	0	**0**
14	Project	PROJ-CS401	Innovative Project - II	0	0	0	**1**
15	MOOCs (Mandatory for Honours)	MOOC 4	Massive Open Online Courses (Mandatory for B.Tech(Honours))	0	0	0	**1**
Total Credit Points of Semester [for B.Tech]				**20**	**1**	**14**	**29**
Total Credit Points of Semester [for B.Tech (Hons.)]							**30**

Semester : 5							
Sr. No	**Type of Course**	**Course Code**	**Course Title**	**Hours per week**			
				Lecture	**Tutorial**	**Practical**	**Credits**
1	Engineering Science Course	ESC501	Signals & Systems	3	0	0	**3**
2	Professional Core Courses	PCC-CS501	Database Management Systems	3	0	0	**3**
3	Professional Core Courses	PCC-CS591	Database Management Systems Laboratory	0	0	4	**2**
4	Professional Core Courses	PCC-CS502	Formal Language & Automata Theory	3	0	0	**3**
5	Professional Core Courses	PCC-CS503	Object Oriented Programming	2	0	0	**2**
6	Professional Core Courses	PCC-CS593	Object Oriented Programming Laboratory	0	0	4	**2**
7	Professional Core Course	PCC-CS504	Software Engineering	2	0	0	**2**
8	Professional Core Course	PCC-CS594	Software Engineering Laboratory	0	0	2	**1**
9	Humanities and social sciences including Management Courses	HSMC501	Humanities II (Principles of Management)	3	0	0	**3**
10	Professional Elective Courses	PEC-CS501	Professional Elective-I	3	0	0	**3**
11	Mandatory Courses	MC501	Constitution of India & Essence of Indian Knowledge Tradition	0	0	0	**0**
12	Humanities and social sciences including Management Courses	HSMC502	Universal Human Values – V	3	0	0	**3**
13	Mandatory Additional Requirements (MAR)	MC581	Mandatory Additional Requirements (MAR)	0	0	0	**0**
14	Project	PROJ-CS501	Innovative Project - III	0	0	0	**1**
15	MOOCs (Mandatory for Honours)	MOOC 5	Massive Open Online Courses (Mandatory for B.Tech(Honours))	0	0	0	**2**
Total Credit Points of Semester [for B.Tech]				22	0	10	**28**
Total Credit Points of Semester [for B.Tech (Hons.)]							**30**

Semester : 6							
Theory Papers							
Sr. No	**Type of Course**	**Course Code**	**Course Title**	**Hours per week**			
				Lecture	**Tutorial**	**Practical**	**Credits**
1	Professional Core Courses	PCC-CS601	Compiler Design	3	0	0	**3**
2	Professional Core Courses	PCC-CS691	Compiler Design Laboratory	0	0	4	**2**
3	Professional Core Courses	PCC-CS602	Computer Networks	3	0	0	**3**
4	Professional Core Courses	PCC-CS692	Computer Networks Laboratory	0	0	4	**2**
5	Professional Core Course	PCC-CS603	Cloud Computing & IOT	2	0	0	**2**
6	Professional Core Course	PCC-CS693	Cloud Computing & IOT Laboratory	0	0	2	**1**
7	Professional Elective Course	PEC-CS601	Professional Elective-II	3	0	0	**3**
8	Professional Elective Course	PEC-CS602	Professional Elective-III	3	0	0	**3**
9	Open Elective Courses	OEC-CS601	Open Elective-I	3	0	0	**3**
10	Project	PROJ-CS601	Project – I	0	0	6	**3**
11	Humanities and social sciences including Management Courses	HSMC602	Universal Human Values – VI	3	0	0	**3**
12	Mandatory Additional Requirements (MAR)	MC681	Mandatory Additional Requirements (MAR)	0	0	0	**0**
13	MOOCs (Mandatory for Honours)	MOOC 6	Massive Open Online Courses (Mandatory for B.Tech(Honours))	0	0	0	**1.5**
Total Credit Points of Semester [for B.Tech]				20	0	16	**28**
Total Credit Points of Semester [for B.Tech (Hons.)]							**29.5**

Semester : 7							
Sr. No	**Type of Course**	**Course Code**	**Course Title**	**Hours per week**			
				Lecture	**Tutorial**	**Practical**	**Credits**
1	Professional Core Course	PCC-CS701	Network Security & Cryptograpghy	2	0	0	**2**
2	Professional Elective Courses	PEC-CS701	Professional Elective - IV	3	0	0	**3**
3	Professional Elective Courses	PEC-CS702	Professional Elective - V	3	0	0	**3**
4	Open Elective Courses	OEC-CS701	Open Elective-II	3	0	0	**3**
5	Project	PROJ-CS701	Project – II	0	0	12	**6**
6	Humanities and social sciences including Management Courses	HSMC702	Universal Human Values – VII	3	0	0	**3**
7	Mandatory Additional Requirements (MAR)	MC781	Mandatory Additional Requirements (MAR)	0	0	0	**0**
8	MOOCs (Mandatory for Honours)	MOOC 7	Massive Open Online Courses (Mandatory for B.Tech(Honours))	0	0	0	**5**
Total Credit Points of Semester [for B.Tech]				14	0	12	**20**
Total Credit Points of Semester [for B.Tech (Hons.)]							**25**

Semester : 8							
Theory Papers							
Sr. No	**Type of Course**	**Course Code**	**Course Title**	**Hours per week**			
				Lecture	**Tutorial**	**Practical**	**Credits**
1	Professional Elective Courses	PEC-CS801	Professional Elective -VI	3	0	0	**3**
2	Open Elective Courses	OEC-CS801	Professional Open Elective-III	3	0	0	**3**
3	Open Elective Courses	OEC-CS802	Professional Open Elective-IV	3	0	0	**3**

4	Project	PROJ-CS801	Project – III	0	0	12	**6**
5	Humanities and social sciences including Management Courses	HSMC802	Universal Human Values – VIII	3	0	0	**3**
6	Grand Viva	PCC-CS881	Grand Viva-Voce	0	0	0	**2**
7	Mandatory Additional Requirements (MAR)	MC881	Mandatory Additional Requirements (MAR)	0	0	0	**0**
8	MOOCs (Mandatory for Honours)	MOOC8	Massive Open Online Courses (Mandatory for B.Tech(Honours))	0	0	0	**5**
Total Credit Points of Semester [for B.Tech]				12	0	12	**20**
Total Credit Points of Semester [for B.Tech (Hons.)]							**25**

Total Credit Points from 3rd to 8th Semester [for B.Tech]				**152**
Total Credit Points from 3rd to 8th Semester [for B.Tech (Hons.)]				**167.5**

Recommended Professional Elective Courses

SL. NO.	**SEMESTER**	**AI & Machine Learning track**	**IoT, Cybersecurity & Blockchain track**
PEC-1	Sem - 5	Neural Networks and Deep Learning	Cybersecurity
PEC-2	Sem - 6	Soft Computing	Human Computer Interaction
PEC-3	Sem - 6	Data Analytics	Blockchain Technology
PEC-4	Sem - 7	Speech and Natural Language Processing	Embedded Systems
PEC-5	Sem - 7	Image Processing	Digital Forensics
PEC-6	Sem - 8	Quantum Computing	Cyber Law, IPR & Ethics

Recommended Open Elective Courses

SL. NO.	SEMESTER	AI & Machine Learning track	IoT, Cybersecurity & Blockchain track
OEC-1	Sem - 6	Human Resource Development and Organizational Behavior	Human Resource Development and Organizational Behavior
OEC-2	Sem - 7	Cyber Security	Data Analytics
OEC-3	Sem - 7	Cyber Law, IPR & Ethics	Neural Networks and Deep Learning
OEC-4	Sem - 8	Digital Forensics	Quantum Computing

Students are also allowed to take Professional Elective Courses and Open Elective Courses from the following list

Theory and Algorithms	Systems	Data Science and Machine Intelligence	Applications	Open Electives
PEC-CS-T-	**PEC-CS-S-**	**PEC-CS-D-**	**PEC-CS-A-**	**OEC-CS-**
Theory of Computation	Advanced Computer Architecture	Artificial Intelligence	Image Processing	Soft Skills and Interpersonal Communication
Graph Theory	Software Engineering	Machine Learning	Digital Signal Processing	Human Resource Development and Organizational Behavior
Advanced Algotrithms	Distributed Systems	Data Mining	Cloud Computing	Cyber Law and Ethics
Parallel Distributed Algorithms	Embedded Systems	Soft Computing	Human Computer Interaction	Introduction Philosophical Thoughts
Computational Complexity	Advanced Operating Systems	Speech and Natural Language Processing	Electronic Design Automation	Comparative Study of Literature
Computational Geometry	Low Circuits Systems	Data Analytics	Computer Graphics	Indian Music System
Queuing Theory and Modeling	Fault Tolerant Computing	Information Retrieval	VLSI System Design	Introduction Art Aesthetics
Computational Number Theory	Real Time Systems	Neural Networks and Deep Learning	Optimization Techniques	History of Science and Engineering
Quantum Computing	Ad-Hoc Sensor Networks	Multi-agent Intelligent Systems	Web and Internet Technology	Economic Policies in India

Information Theory and Coding	Signals and Networks		Cryptography and Network Security	
	Internet of Things			

CST & CSIT

DETAILED SYLLABUS

B.Tech 2nd Year 3rd Semester

Course Code: ESC301
Course Title: Analog Electronic Circuits
Credit: 3

Module-1: [10]

1. Filters and Regulators: Capacitor filter, π-section filter, ripple factor, series and shunt voltageregulator, percentage regulation, 78xx and 79xx series, concept of SMPS. [4]

2. Transistor Biasing and Stability: Q-point, Self Bias-CE, Compensation techniques, h-model oftransistors. Expression for voltage gain, current gain, input and output impedance, trans-resistance &trans-conductance; Emitter follower circuits, High frequency model of transistors. [6]

Module -2: [10]

1. Transistor Amplifiers: RC coupled amplifier, functions of all components, equivalent circuit, derivationof voltage gain, current gain, input impedance and output impedance, frequency response characteristics,lower and upper half frequencies, bandwidth, and concept of wide band amplifier. [6]

2. Feedback Amplifiers & Oscillators: Feedback concept, negative & positive feedback, voltage/ current,series/shunt feedback, Berkhausen criterion, Colpitts, Hartley's, Phase shift, Wein bridge and crystaloscillators. [4]

Module -3: [10]

1. Operational Amplifier: Ideal OPAMP, Differential Amplifier, Constant current source (current mirroretc.), level shifter, CMRR, Open & Closed loop circuits, importance of feedback loop (positive &negative), inverting & noninverting amplifiers, voltage follower/buffer circuit. [6]

2. Applications of Operational Amplifiers: adder, integrator & differentiator, comparator, Schmitt
Trigger. Instrumentation Amplifier, Log & Anti-log amplifiers, Trans-conductance multiplier, PrecisionRectifier, voltage to current and current to voltage converter, free running oscillator. [6]

Module -4: [8]

Multivibrator – Monostable, Bistable, Astable multivibrators; Monostable and astable operation using555 timer. [2]

Text Books:1.Microelectronic Circuits, Sedra & Smith, Oxford University Press.
2.Integrated Electronics, Milman & Halkias, Mc Graw Hill Company.
3.Electronic devices & Circuits, Balbir Kumar & Shail B. Jain, PHI.
4.Op-amps and Linear IC's, R.A. Gayakwad, PHI.

Reference Books:1.Microelectronic Circuit- Analysis & Design, Rashid, Cenage Learning.
2.Electronic Circuits: Discrete & Integrated, 3rd Edition, Schilling & Belove, Mc Graw Hill Company.
3.Electronic principles, 6th Edition, Malvino, Mc Graw Hill Company.
4.Operational Amplifier & Linear IC's, Bell, Oxford University Press.
5.2000 Solved Problems in Electronics, Jimmie J. Cathey, Mc Graw Hill Inc.
6.Electronic Devices -System & Application, Robert Diffenderfer, Cengage Learning.
7.Op- Amps & Linear Integrated Circuits, Ravi Raj Dudeja & Mohan Dudeja, Umesh Publication

Course Code: ESC391
Course Title: Analog Electronic Circuits Laboratory
Credit: 2

1. Study of Ripple and Regulation characteristics of full wave rectifier with and without capacitor filter.
2. Study of Zener diode as voltage regulator.
3. Construction of two stage R-C coupled amplifier & study of its gain and Bandwith.
4. Realisation V-I & I-V converter using Operational Amplifier.
5. Study of timer circuit using NE 555 and configuration of Monostable and Astable Multivibrator.
6. Study of DAC & ADC
7. Design of Combinational circuit for BCD to decimal conversion to drive 7-segment display using Multiplexer.
8. Study of Inverting and Non Inverting Aplifier using Op-Amp
9. Study of Voltage Adder Circuit using Op-Amp
10. Study of Voltage Subtractor Using Op Amp

Course Code: PCC-CS301
Course Title: Data Structure & Algorithms
Credit: 3

Linear Data Structure:

Introduction:

Why we need data structure?

Concepts of data structures: a) Data and data structure b) Abstract Data Type and Data Type.

Applications

Algorithms and programs, basic idea of pseudo-code.

Algorithm efficiency and analysis, time and space analysis of algorithms – order notations.

Array:

Different representations – row major, column major.

Sparse matrix - its implementation and usage. Array representation of polynomials.

Linked List:

Singly linked list, circular linked list, doubly linked list, linked list representation of polynomial and applications.

Stack and Queue:

Stack and its implementations (using array, using linked list), applications.

Queue, circular queue, dequeue. Implementation of queue- both linear and circular (using array, using linked list), applications.

Recursion:

Principles of recursion – use of stack, differences between recursion and iteration, tail recursion.

Applications - The Tower of Hanoi.

Nonlinear Data structures:

Trees:

Basic terminologies, tree representation (using array, using linked list).

Binary trees - binary tree traversal (pre-, in-, post- order), recursive and non-recursive traversal algorithms of binary tree, threaded binary tree (left, right, full), and expression tree.

Binary search tree- operations (creation, insertion, deletion, searching).

Height balanced binary tree – AVL tree (insertion, deletion with examples only).

B- Trees – operations (insertion, deletion with examples only).

B+ Trees – operations (insertion, deletion with examples only).

Graphs:

Graph definitions and concepts (directed/undirected graph, weighted/un-weighted edges, sub-graph, degree, cut vertex/ articulation point, pendant node, clique, complete graph, connected components – strongly connected component, weakly connected component, path, shortest path, and isomorphism). Graph representations/storage implementations – adjacency matrix, adjacency list, adjacency multi-list. Graph traversal and connectivity – Depth-first search (DFS), Breadth-first search (BFS) – concepts of edges used in

DFS and BFS (tree-edge, back-edge, cross-edge, forward-edge), applications.

Minimal spanning tree – Prim's algorithm (basic idea of greedy methods).

Searching and Sorting:

Sorting Algorithms: Bubble sort and its optimizations, insertion sort, shell sort, selection sort, merge sort, quick sort, heap sort (concept of max heap, application – priority queue), radix sort.

Searching: Sequential search, binary search, interpolation search.

Hashing: Hashing functions, collision resolution techniques.

Learning Resources:

1. "Data Structures and Program Design In C", 2/E by Robert L. Kruse, Bruce P. Leung.

2. "Fundamentals of Data Structures of C" by Ellis Horowitz, Sartaj Sahni, Susan Anderson-freed.

3. "Data Structures in C" by Aaron M. Tenenbaum.

4. **"**Data Structures" by S. Lipschutz.

5. "Data Structures Using C" by Reema Thareja.

6. "Data Structure Using C", 2/e by A.K. Rath, A. K. Jagadev.

7. **"**Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein.

Course Code: PCC-CS391

Course Title: Data Structure & Algorithms Laboratory

Credit: 2

1.Implementation of array operations: Stacks and Queues: adding, deleting elements Circular Queue: Adding & deleting elements Merging Problem: Evaluation of expressions operations on multiple stacks & queues.

2.Implementation of linked lists: inserting, deleting, and inverting a linked list. 3.Implementation of stacks & queues using linked lists, Polynomial addition, 4.Polynomial multiplication, Sparse Matrices: Multiplication, addition.

5.Recursive and Non recursive traversal of Trees, Threaded binary tree, binary search tree .

6.Application of sorting and searching algorithms.

7.Hash tables implementation: searching, inserting and deleting, searching & sorting techniques.

Course Code: ECS302

Course Title: Digital Electronics

Credit: 3

Module 1:

Binary Number System & Boolean Algebra (recapitulation) [1L];

BCD, ASCII, EBCDIC, Gray codes and their conversions [2L];

Signed binary number representation with 1's and 2's complement methods [1L],

Binary arithmetic, Venn diagram, Boolean algebra (recapitulation) [1L];

Representation in SOP and POS forms [1L];

Minimization of logic expressions by KMAP [3L]

Quine-McCluskey Minimization Technique (Tabular Method) [2L]

Binary Number System & Boolean Algebra (recapitulation) [1L];

BCD, ASCII, EBCDIC, Gray codes and their conversions [2L];

Signed binary number representation with 1's and 2's complement methods [1L],

Binary arithmetic, Venn diagram, Boolean algebra (recapitulation) [1L];

Representation in SOP and POS forms [1L];

Minimization of logic expressions by KMAP [3L]

Quine-McCluskey Minimization Technique (Tabular Method) [2L]

Module 2

Combinational circuits - Adder and Subtractor circuits (half & full adder & subtractor) [2L];

Encoder,Decoder, Comparator, Multiplexer, De-Multiplexer and Parity Generator [4L].

Module 3

Sequential Circuits - Basic Flip-flop & Latch [1L],

Flip-flops -SR, JK, D, T and JK Master-slave Flip Flops [3L]

Registers (SISO,SIPO,PIPO,PISO) [2L],

Ring counter, Johnson counter [1L],

Basic concept of Synchronous and Asynchronous counters (detail design of circuits excluded), [2L],

Design of Mod N Counter [2L]

Module 4:

A/D and D/A conversion techniques – Basic concepts (D/A :R-2-R only [2L]

A/D: successive approximation [2L]) (4L)

Logic families- TTL, ECL, MOS and CMOS - basic concepts.(2L)

Learning Resources:

1. Digital Logic Design by Morris Mano - PHI

2. Digital Electronics by S. Salivahanan,S. Arivazhagan-OXFORD

3. Digital Electronics by P.Raja - Scitech Publications

4. Digital Fundamentals by Floyed & Jain -Pearson.

5. Microelectronics Engineering by Sedra & Smith-Oxford.

6. Principles of Electronic Devices & circuits by B L Thereja & Sedha, S Chand Digital Electronics, Kharate – Oxford

Course Code: ECS392
Course Title: Digital Electronics Laboratory
Credit: 2

1) Familiarity with basic gates ICs and Realization of NOT,AND,OR and XOR operations by using universal gates (both NAND and NOR). - Design some basic logic circuits using basic gates ICs.
2) Design a circuit to indicate 4 bit odd and even numbers.
3) Realization of a circuit to display prime and non prime numbers (4 bit).
4) Implementation of Half Adder. Implementation of Full Adder. Carryout expression is implemented by basic gates.
5) Implementation of Full Adder by using 2 half Adders and an OR gate.
6) Implementation of Half Subtractor.
7) Implementation of Full Subtractor. Borrowout expression is implemented by basic gates.
8) Implementation of Full Subtractor using 2 Half Subtractors and an OR gate.
9) Realization of a circuit to convert BCD to Excess -3 codes.
10) Realization of a circuit to convert Excess -3 codes to BCD.
11) Design a circuit to convert 4 bit Binary to 4 bit Gray code.

12) Design a circuit to convert 4 bit Gray code to 4 bit Binary.
13) Realization of an Even Parity Generator and Checker circuit.
14) Implementation of 2 bit comparator circuit.
15) Realization of the internal architecture of 4:1 Multiplexer and 1:4 De-multiplexer.
16) Implementation of Full Adder using MUX IC 4539B.
17) Implementation of Full Subtractor using MUX IC 4539B.
18) Realization of 4:2 Priority Encoder along with output indicator (basic gates).
19) Realization of the internal architecture of 3:8 Decoder using basic gates.
20) Realization of octal to binary encoder using basic gates.
21) Implement Full Adder using IC 4008.
22) Implement Full Subtractor using IC 4008.
23) Truth table verification of SR flip-flop (using NAND gates only).
24) Truth table verification of D flip-flop (using NAND gates only).
25) Truth table verification of JK flip-flop (using NAND gates only).
26) Truth table verification of T flip-flop (using NAND gates only).
27) Design a Master slave flip-flop.
28) Design 4-bit synchronous up counter.
29) Design 4-bit synchronous down counter.
30) Design 4-bit asynchronous up counter.
31) Design 4-bit asynchronous down counter.
32) Design a 3-bit synchronous up/down' counter using JK flip-flop with external mode signal
M. If M=1,counter counts up and with M=0, counter counts down.
33) Design and implement MOD-4 Ring counter.
34) Design a Johnshon counter.
35) Design a Decade counter.
36) Design an unit distance code counter.
37) Realization of Serial-in-Serial-Out shift register.
38) Realization of Serial-In-Parallel Out Shift register.
39) Realization of Parallel-In-Parallel Out Shift register.
40) Realization of Parallel-In-Serial Out Shift register.
41)Realization of Bidirectional shift register (All using D flip-flops).

Learning Resources:

1. Digital Logic Design by Morris Mano – PHI
2. Digital Electronics by S. Salivahanan,S. Arivazhagan-OXFORD
3. Digital Electronics by P.Raja - Scitech Publications
4. Digital Fundamentals by Floyed & Jain -Pearson.
5. Microelectronics Engineering bySedra & Smith-Oxford.
6. Principles of Electronic Devices & circuits by B L Thereja & Sedha, S Chand Digital Electronics ,Kharate – Oxford

Course Code: PCC-CS302

Course Title: IT Workshop (Sci Lab / MATLAB/ Python / R)

Credit: 1

Course Code: PCC-CS392

Course Title: IT Workshop Practical (Sci Lab / MATLAB/ Python / R)

Credit: 2

Course Code: BSC301

Course Title: Mathematics – III (Differential Calculus, Probability, Statistics)

Credit: 2

Course Code: HSMC301

Course Title: Humanities – I (Technical Report Writing using Latex)

Credit: 3

Course Code: HSMC302

Course Title: Universal Human Values – III

Credit: 3

Course Code: MC381

Course Title: Mandatory Additional Requirements (MAR)

Credit: 0

Course Code: PROJ-CS301

Course Title: Innovative Project - I

Credit: 1

Course Code: MOOC 3

Course Title: Massive Open Online Course (Mandatory for B.Tech (Honours))

Credit: 1

B.Tech 2nd Year 4th Semester

Course Code: PCC-CS401

Course Title: Discrete Mathematics

Credit: 4

Propositional Logic:

Logical Connectives, Conjunction, Disjunction, Negation and their truth table. Conditional Connectives, Implication, Converse, Contrapositive, Inverse, Biconditional statements with truth table, Logical Equivalence, Tautology, Normal forms - CNF, DNF; Predicates and Logical Quantifications of propositions and related examples.

Theory of Numbers:

Well Ordering Principle, Divisibility theory and properties of divisibility; Fundamental theorem of Arithmetic;

Euclidean Algorithm for finding G.C.D and some basic properties of G.C.D with simple examples; Congruences, Residue classes of integer modulo ( ) n n Z and its examples;

Order, Relation and Lattices:

POSET, Hasse Diagram, Minimal , Maximal, Greatest and Least elements in a POSET, Lattices and its properties, Principle of Duality, Distributive and Complemented Lattices.

Counting Techniques:

Permutations, Combinations, Binomial coefficients, Pigeon- hole Principle, Principles of inclusion and exclusions; Generating functions, Recurrence Relations and their solutions using generating function, Recurrence relation of Fibonacci numbers and it's solution, Divide-and-Conquer algorithm and its recurrence relation and its simple application in computer.

Graph Coloring:

Chromatic Numbers and its bounds, Independence and Clique Numbers, Perfect Graphs-Definition and examples, Chromatic polynomial and its determination, Applications of Graph Coloring.

Matchings:

Definitions and Examples of Perfect Matching, Maximal and Maximum Matching, Hall's Marriage Theorem (Statement only) and related problems.

Learning Resources:

1. Kenneth H. Rosen, Discrete Mathematics and Its Applications, McGraw Hill.
2. Russell Merris, Combinatorics, WILEY-INTERSCIENCE SERIES IN DISCRETE MATHEMATICS AND OPTIMIZATION
3. N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI
4. Gary Haggard, John Schlipf and Sue Whitesides, Discrete Mathematics for Computer Science, CENGAGE Learning.
5. Gary Chartrand and Ping Zhang – Introduction to Graph Theory, TMH

Course Code: PCC-CS402

Course Title: Computer Organization & Architecture

Credit: 3

Module 1:

- Introduction to computer organisation & architecture
- Basic organization of the stored program computer and operation sequence for execution of a program. Role of operating systems and compiler/assembler.
- Fetch, decode and execute cycle, Concept of operator, operand, registers and storage, Instruction format. Instruction sets and addressing modes
- Quantitative techniques in computer design - Part1
- Introduction to RISC architectures. RISC vs CISC architectures

Module 2:

- Commonly used number systems. Fixed and floating-point representation of numbers; Concept of Overflow and Underflow.
- Design of adders - ripple carry and carry look ahead principles.
- Fixed point multiplication - Unsigned and Signed - Booth's algorithm.
- Fixed point division - Restoring and non-restoring algorithms.
- Floating point - IEEE 754 standard.
- Design of ALU.
- Design of control unit - hardwired and microprogrammed control.
- Introduction to Von-Nuemann & Harvard Architecture

Module 3:

- Memory organization, static and dynamic memory, memory hierarchy, associative memory.
- Hierarchical memory technology: Inclusion, Coherence and locality properties
- Cache memory organizations, Techniques for reducing cache misses;
- Virtual memory organization, mapping and management techniques, memory replacement policies.
- Memory unit design with special emphasis on implementation of CPU-memory interfacing. Data path design for read/write access.
- I/O operations - Concept of handshaking, Polled I/O, interrupt and DMA

Module 4:

- Quantitative techniques in computer design - Part2
- Pipelining: Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards and structural hazards, techniques for handling hazards.
- Pipeline optimization techniques, Compiler techniques for improving performance.
- Instruction-level parallelism: basic concepts, techniques for increasing ILP, superscalar, superpipelined architectures. Array and vector processors.

Module 5:

- Multiprocessor architecture: taxonomy of parallel architectures - Introduction to Flynn's Classification; Centralized shared - memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared memory architecture.
- Non von-Neumann architectures - Data flow computers.

Learning Resources:

1. Computer Organization and Architecture: Designing for Performance, William Stallings, Prentice-Hall India
2. Computer Organization, Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Tata McGraw Hill
3. Computer Architecture A Quantitative Approach, John L Hennessy and David Patterson, Morgan Kaufman
4. Structured Computer Organization, Andrew S. Tanenbaum, Prentice-Hall India
5. Computer Architecture & Parallel Processing. Kai Hwang & Briggs, Tata McGraw Hill
6. Computer System Architecture, M. M. Mano, PHI.
7. Computer Organization & Architecture, P N Basu, Vikas Publication

Course Code: PCC-CS492

Course Title: Computer Organization & Architecture Laboratory

Credit: 2

Hardware Experiments:

1. Design a 3 bit carry save adder circuit
2. Design a 2 bit Serial adder circuit
3. Design a 3 bit Carry skip adder
4. Design a 3 bit Manchester chain adder
5. Design a 3 bit Carry select adders
6. Design a 3 bit Pre-Fix Adders
7. Design a 3 bit Multi-operand adder
8. Design a 3 bit Pipelined parallel adder
9. Design a circuit to construct a n-bit common bus using 4 n-bit registers and n no. of MUX each of 4×1
10. Design a circuit to construct a 2-bit common bus using Tri state buffer and decoder
11. Design a circuit to construct a 4-bit binary Incremental unit
12. Design a circuit to construct a 4-bit binary Decrementor unit
13. Design a circuit to construct a 3-bit combinational shifter unit
14. Design a circuit to construct a 16bit processor composed 4 4-bit slices
15. Design a 4×4 array multiplier to perform multiplication of 2 unsigned integer
16. Design a digital circuit to perform Sequential multiplication method for unsigned integer
17. Design a digital circuit to perform Booth's multiplication procedure for signed number
18. Design a digital circuit to perform Restoring division method based on 2 unsigned integer
19. Design a digital circuit to perform Non-restoring division method based on 2 unsigned integer
20. Design a single error detecting and correcting circuit using hamming code approach
21. Design a Multiplier control unit by using hardwired control design approach
22. Design a control unit by using multi-program control design approach
23. Design a micro program sequencer unit
24. Design a 16-bit CPA using 4-bit CPA

Software simulation:

1. HDL introduction

2. Basic digital logic base programming with HDL
3. 8-bit Addition, Multiplication, Division
4. 8-bit Register design
5. Memory unit design and perform memory operations.
6. 8-bit simple ALU design
7. 8-bit simple CPU design
8. Interfacing of CPU and Memory

Learning Resources:

1. Computer Organization and Architecture: Designing for Performance, William Stallings, Prentice-Hall India

2. Computer Organization, Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Tata McGraw Hill

3. Computer Architecture A Quantitative Approach, John L Hennessy and David Patterson, Morgan Kaufman

4. Structured Computer Organization, Andrew S. Tanenbaum, Prentice-Hall India

5. Computer Architecture & Parallel Processing. Kai Hwang & Briggs, Tata McGraw Hill

6. Computer System Architecture, M. M. Mano, PHI.

7. Computer Organization & Architecture, P N Basu, Vikas Publication

Course Code: PCC-CS403

Course Title: Operating systems

Credit: 3

Introduction to OS. Operating system functions, evaluation of O.S., Different types of O.S.: batch, multi-programmed, time-sharing, real-time, distributed, parallel. [4]

Computer system operation, I/O structure, storage structure, storage hierarchy, different types of protections, operating system structure (simple, layered, virtual machine), O/S services, system calls. [4]

Processes [3L]: Concept of processes, process scheduling, operations on processes, co-operating processes, inter-process communication.

Threads [2L]: overview, benefits of threads, user and kernel threads.

CPU scheduling [3L]: scheduling criteria, preemptive & non-preemptive scheduling, scheduling algorithms (FCFS, SJF, RR, priority), algorithm evaluation, multi-processor scheduling.

Process Synchronization [5L]: background, critical section problem, critical region, synchronization hardware, classical problems of synchronization, semaphores.

Deadlocks [4L]: system model, deadlock characterization, methods for handling deadlocks, deadlock prevention, deadlock avoidance, deadlock detection, recovery from deadlock. [16]

Memory Management [5L]: background, logical vs. physical address space, swapping, contiguous memory allocation, paging, segmentation, segmentation with paging.

Virtual Memory [3L]: background, demand paging, performance, page replacement, page replacement algorithms (FCFS, LRU), allocation of frames, thrashing.

File Systems [4L]: file concept, access methods, directory structure, file system structure, allocation methods (contiguous, linked, indexed), free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency & performance.

I/O Management [4L]: I/O hardware, polling, interrupts, DMA, application I/O interface (block and character devices, network devices, clocks and timers, blocking and non-blocking I/O), kernel I/O subsystem (scheduling, buffering, caching, spooling and device reservation, error handling), performance.

Disk Management [4L]: disk structure, disk scheduling (FCFS, SSTF, SCAN,C-SCAN) , disk reliability, disk formatting, boot block, bad blocks. [20]

Goals of protection, domain of protection, security problem, authentication, one time password, program threats, system threats, threat monitoring, encryption. [4]

Learning Resources:

1. Milenkovie M., “Operating System : Concept & Design”, McGraw Hill.
2. Tanenbaum A.S., “Operating System Design & Implementation”, Practice Hall NJ.
3. Silbersehatz A. and Peterson J. L., “Operating System Concepts”, Wiley.
4. Dhamdhere: Operating System TMH
5. Stalling, William, “Operating Systems”, Maxwell McMillan International Editions, 1992.
6. Dietel H. N., “An Introduction to Operating Systems”, Addison Wesley

Course Code: PCC-CS493
Course Title: Operating Systems Laboratory
Credit: 2

1. **Shell programming [6P]**: creating a script, making a script executable, shell syntax (variables, conditions, control structures, functions, commands).

2. **Process [6P]**: starting new process, replacing a process image, duplicating a process image, waiting for a process, zombie process.

3. **Signal [9P]**: signal handling, sending signals, signal interface, signal sets.

4. **Semaphore [6P]**: programming with semaphores (use functions semctl, semget, semop, set_semvalue, del_semvalue, semaphore_p, semaphore_v).

5. **POSIX Threads [9P]**: programming with pthread functions(viz. pthread_create, pthread_join, pthread_exit, pthread_attr_init, pthread_cancel)

6. **Inter-process communication [9P]**: pipes(use functions pipe, popen, pclose), named pipes(FIFOs, accessing FIFO)

Course Code: PCC-CS404
Course Title: Design & Analysis of Algorithms
Credit: 3

1. Introduction: Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Master's theorem; Divide and Conquer algorithms – Merge Sort, Quick Sort, Finding lower bound of comparison-based sorting algorithms, Strassen's algorithm for multiplying matrices. 8

2 Fundamental Algorithmic Strategies: Brute-force, Greedy, Dynamic Programming, Branch and Bound and Backtracking methodologies for the design of algorithms; Illustrations of these techniques for Problem solving, Bin Packing, Knapsack, TSP, Heuristics – characteristics and their application domains, KMP algorithm. 8

3 Graph and Tree Algorithms: Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS), Disjoint Set Data Structures, Shortest paths algorithms, Minimum Spanning Tree, Topological sorting, Network Flow Problem. 6

4 Tractable and Intractable Problems: Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard, Cook's theorem, Standard NP-complete problems and Reduction techniques. 10

5 Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE. 4

Learning Resources:

1. Introduction to Algorithms, 4th Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.

2. Algorithms, 4th Edition, Robert Sedgewick and Kevin Wayne, Princeton University.

3. Fundamental pf Algorithms – E. Horowitz et al.

4. Algorithm Design, 1st Edition, Jon Kleinberg and EvaTardos, Pearson.

5. Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley.

6. Algorithms – A Creative Approach, 3rd Edition, UdiManber, Addison-Wesley, Reading, MA.

7. Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing Housh (AICTE Recommended Textbook – 2018)

8. Algorithms Design and Analysis, Udit Agarwal, Dhanpat Rai.

Course Code: PCC-CS494
Course Title: Design & Analysis of Algorithms Laboratory
Credit: 2

1 Divide and Conquer Algorithm:

Implement Binary Search using Divide and Conquer approach, Implement Merge Sort using Divide and Conquer approach, Implement Quick Sort using Divide and Conquer approach, Find the Maximum and the Minimum element from a given array of integers using Divide and Conquer approach, Find the Median of two sorted arrays using Divide and Conquer approach, Find the Bitonic point in Bitonic sequence using Divide and Conquer approach, Implement the Multiplication of two matrices using Strassen's Divide and Conquer approach, Find the neighbors of the Median element using the partitioning strategy of Quick Sorting method.

Linear-time Sorting Algorithm:

Implement Count Sort, Implement Dictionary Sorting Strategy.

2 Dynamic Programming:

Implement the Coin-exchange problem using Dynamic Programming, Find the Minimum number of scalar multiplications needed for a given chain of matrices using Dynamic Programming, Implement the Single Source Shortest Paths problem for a given directed graph (Bellman-Ford algorithm), Implement the All-Pair Shortest Paths problem for a given directed graph (Floyd-Warshall algorithm), Implement the Traveling Salesman Problem using Held-Karp algorithm, Find the minimum edit distances to convert one string into another string using Dynamic Programming, Implement the 0-1 Knapsack problem using Dynamic Programming, Implement the Subset-Sum problem using Dynamic Programming.

3 Branch and Bound:

Implement the 15-Puzzle Problem using Branch and Bound algorithm.

Backtracking:

Implement the 8-Queen Problem using Backtracking, Implement the Graph Coloring Problem using Backtracking, Implement the Hamiltonian Problem using Backtracking.

4 Greedy Algorithm:

Implement the Fractional Knapsack Problem using greedy method, Implement the Job sequencing with deadlines using greedy method, Implement the Single Source Shortest Paths problem for a given directed graph (Dijkstra's algorithm), Implement the Minimum Cost Spanning Tree using Prim's algorithm, Implement the Minimum Cost Spanning Tree using Kruskal's algorithm.

Fundamental Graph Algorithm:

Implement Breadth First Search (BFS), Implement Depth First Search (DFS), Find all Strongly Connected components of a given directed graph using Kosaraju's algorithm, Implement the Union-Find algorithm, Find the Max-Flow of a given Flow network using Ford-Fulkerson method.

String Matching Problem:

Implement the String Matching Problem using Knuth-Morris-Pratt algorithm.

Learning Resources:

1. Introduction to Algorithms, 4th Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.

2. Algorithms In A Nutshell, George T. Heineman, Gary Pollice and Stanley Selkow, O'Reilly.

3. Fundamental pf Algorithms – E. Horowitz et al.

4. Algorithm Design, 1st Edition, Jon Kleinberg and EvaTardos, Pearson.

5. Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley.

6. Algorithms – A Creative Approach, 3rd Edition, UdiManber, Addison-Wesley, Reading, MA.

7. Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing Housh (AICTE Recommended Textbook – 2018).

Course Code: PCC-CS405

Course Title: Artificial Intelligence & Machine Learning

Credit: 2

Module 1: Introduction to Artificial Intelligence [1L]: The Foundations of Artificial Intelligence, The History of Artificial Intelligence, and the State of the Art.

Knowledge Representation [4L]: A Knowledge-Based Agent, Knowledge Representation, Reasoning & Logic, Propositional Logic, Inference in First-Order Logic

Search techniques [4L]: AI-Problem formulation, Solving problems by searching, uninformed search strategies: depth first search, breadth first search, depth limited search, iterative deepening search, bi-directional search.

Heuristic search strategies [4L] : Basics of heuristics, hill climbing strategy, simulated annealing strategy, best-first search, A* search, constraint satisfaction problem solving strategy.

Adversarial search [2L]: AI-based interactive game playing scheme using the minimax strategy, alpha-beta pruning.

Module 2: Introduction to Machine Learning [2L]: Machine learning and it's types; Applications of machine learning; Issues in machine learning.

Module 3:Recapitulation of Linear Algebra, Bayes Theorem, Expectation, Variance, Matrix Calculus – Numerical Optimization – Gradient Descent

Module 4: Linear Regression – Least Square Gradient Descent Method – Derivations – Goodness of Fit – Bias-Variance Trade off.

Module 5: Logistic Regression – Sigmoid – Gradient of Logistic Regression – Binary Cross Entropy cost function.

Module 6: Artificial Neural Networks – Multinomial Classification – One-Hot-Vector – Backpropagation – Derivations, Realization of Gates (AND, OR, XOR, NAND)

Module 6: Introduction to Convolutional Neural Networks – Regularization - CNN architectures – LeNet – VGG Net – Google Net – ResNet. Image classification – Hyperparameter optimization – Transfer learning – case studies

Module 7: Introduction to Recurrent Neural Networks – Deep RNNs – Bi-RNNs – Long Short-Term Memory – Vanishing gradient

Module 8: Recap - Data preprocessing – Normalization – Feature Selection – Feature Reduction – PCA - local linear embedding, ISOmap, multidimensional scaling, Performance Evaluation of Classifiers – Cross Validation – Receiver Operating Characteristics Curve

Module 9: Lazy Learners – nearest neighbors – Decision Tree – CART – Ensemble Methods – Bagging – Boosting – Random Forest – Semi Supervised Learning

Module 10: Clustering – Partitioning Methods – K-means – K-medoids – Fuzzy Clustering – Hierarchical methods – Agglomerative Nesting (AGNES) – Performance Evaluation

Module 5: Introduction to Convolutional Neural Networks – Regularization - CNN architectures – LeNet – VGG Net – Google Net – ResNet. Image classification – Hyperparameter optimization – Transfer learning – case studies

Module 6: Introduction to Recurrent Neural Networks – Deep RNNs – Bi-RNNs – Long Short-Term Memory – Vanishing gradient

Module 7: Recap - Data preprocessing – Normalization – Feature Selection – Feature Reduction – PCA - local linear embedding, ISOmap, multidimensional scaling, Performance Evaluation of Classifiers – Cross Validation – Receiver Operating Characteristics Curve

Module 8: Lazy Learners – nearest neighbors – Decision Tree – CART – Ensemble Methods – Bagging – Boosting – Random Forest – Semi Supervised Learning

Module 9: Clustering – Partitioning Methods – K-means – K-medoids – Fuzzy Clustering – Hierarchical methods – Agglomerative Nesting (AGNES) – Performance Evaluation

Course Code: PCC-CS495

Course Title: Artificial Intelligence & Machine Learning Laboratory

Credit: 1

Module 1:

1. Implementation of Decision Tree using scikit learn
2. Implementation of Random Forest using scikit learn
3. Implementation of Bagging method using scikit learn
4. Implementation of AdaBoost algorithm using scikit learn

Module 2:

5. Implementation of Ridge Regression using linear_model of scikit learn
6. Implementation of Elastic-Net using linear_model of scikit learn
7. Implementation of Lasso using linear_model of scikit learn
8. Implementation of Support Vector Regressor (with linear & non-linear kernel) using scikit learn

Module 3:

9. Implementation of unsupervised dimensionality reduction using principal component analysis in scikit learn
10. Implement Locally linear embedding (LLE) using scikit learn
11. Implement Isometric Mapping algorithm using scikit learn
12. Implementation of Multi-dimensional Scaling (MDS) using scikit learn
13. Implementation of t-distributed Stochastic Neighbor Embedding (t-SNE) algorithm in scikit learn

Module 4:

14. Implementation of Label Propagation using scikit learn
15. Implementation of Label Spreading using scikit learn

Module 5:

16. Implementation of an Image classifier using 2D Convolutional Neural Network using Tensorflow / Keras

17. Implementation of Long Short Term Memory network using Tensorflow / Keras

Module 6:

18. Familiarization with Confusion matrix based model evaluation metrics using Scikit learn
19. Familiarization with Regression model evaluation metrics using Scikit learn
20. Familiarization with Clustering model evaluation metrics using Scikit learn

Course Code: HSMC401

Course Title: Management – I (Finance & Accounting)
Credit : 3

Course Code: HSMC402

Course Title: Universal Human Values - IV
Credit : 3

Course Code: MC401

Course Title: Environmental Science
Credit : 0

1.Basic ideas of environment, basic concepts, man, society & environment, their interrelationship (1L) Mathematics of population growth and associated problems, Importance of population study in environmental engineering, definition of resource, types of resource, renewable, non-renewable, potentially renewable, effect of excessive use vis-à-vis population growth, Sustainable Development. (2L) Materials balance: Steady state conservation system, steady state system with non-conservative pollutants, step function. (1L) Environmental degradation: Natural environmental Hazards like Flood, earthquake, Landslide-causes, effects and control/management; Anthropogenic degradation like Acid rain-cause, effects and control. Nature and scope of Environmental Science and Engineering. (2L)

2.Elements of ecology: System, open system, closed system, definition of ecology, species, population, community, definition of ecosystem- components types and function. (1L) Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundar ban); Food chain [definition and one example of each food chain], Food web.(2L) Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur]. (1L) Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity.(2L)

3.Atmospheric Composition: Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause. (1L) Energy balance: Conductive and Convective heat transfer, radiation heat transfer, simple global temperature model [Earth as a black body, earth as albedo], Problems.(1L) Green house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food. Global warming and its consequence, Control of Global warming. Earth's heat budget.(1L) Lapse rate: Ambient lapse rate Adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion).(2L) Atmospheric dispersion: Maximum mixing depth, ventilation coefficient, effective stack height, smokestack plumes and Gaussian plume model.(2L) Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants- Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN. (2L) Smog, Photochemical smog and London smog. Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green-house gases, effect of ozone modification. (1L) Standards and control measures: Industrial, commercial and residential air quality standard, control measure (ESP. cyclone separator, bag house, catalytic converter, scrubber (ventury), Statement with brief reference). (1L)

4. Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds. (2L) River/Lake/ground water pollution: River: DO, 5-day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river [deoxygenation, reaeration], COD, Oil, Greases, pH. (2L) Lake: Eutrophication [Definition, source and effect]. (1L) Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only)(1L) Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition. (2L) Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury, Cadmium, and Arsenic (1L)

5.Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds. (2L) River/Lake/ground water pollution: River: DO, 5-day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river [deoxygenation, reaeration], COD, Oil, Greases, pH. (2L) Lake: Eutrophication [Definition, source and effect]. (1L) Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only)(1L) Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition. (2L) Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury, Cadmium, and Arsenic (1L)

Learning Resources:

1. M.P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House (AICTE Recommended Textbook – 2018)

2. Masters, G. M., “Introduction to Environmental Engineering and Science”, Prentice-Hall of India Pvt. Ltd.,1991.

3. De, A. K., “Environmental Chemistry”, New Age International

Course Code: MC481
Course Title: Mandatory Additional Requirements (MAR)
Credit: 0

Course Code: PROJ-CS401

Course Title: Innovative Project - II

Credit: 1

Course Code: MOOC 4

Course Title: Massive Open Online Course (Mandatory for B.Tech (Honours))

Credit: 1

B.Tech 3rd Year 5th Semester

Course Code: ESC501
Course Title: Signals & Systems
Credit: 3

Module I **6L**

Signals and systems as seen in everyday life, and in various branches of engineering and science.

Energy and power signals, continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.

Module II **6L**

Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs. Characterization of causality and stability of linear shift invariant systems. System representation through differential equations.

Module III **8L**

Periodic and semi-periodic inputs to an LSI system, the notion of a frequency response and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. The idea of signal space and orthogonal bases.

Module IV **8L**

Evolution of Transforms: Fourier Transform, Laplace Transform , Z-transform (single sided and Double sided) .The Laplace Transform, notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence, poles and zeros of system, , solution to differential equations and system behavior using Laplace Transformation

The z-Transform for discrete time signals and systems- eigen functions, region of convergence, z-domain analysis.

Module V **4L**

The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ^{ideal} interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems.

Text/Reference books:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall,

1983.

2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.

3. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980

Course Code: Database Management Systems
Course Title: PCC-CS501
Credit: 3
1 Introduction

Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

2 Entity-Relationship Model

Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

3 Relational Model

Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications Of the Database.

4 SQL and Integrity Constraints

Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers.

5 Relational Database Design

Functional Dependency, Different anamolies in designing a Database., Normalization using funtional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Nomalization using multi-valued depedencies, 4NF, 5NF

6 Internals of RDBMS

Physical data structures, Query optimization : join algorithm, statistics and cost bas optimization. Transaction processing, Concurrency control and Recovery Management : transaction model properties, state serializability, lock base protocols, two phase locking.

7 File Organization & Index Structures

File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree .

Learning Resources:

1. Henry F. Korth and Silberschatz Abraham, “Database System Concepts”, Mc.Graw Hill.
2. Elmasri Ramez and Novathe Shamkant, “Fundamentals of Database Systems”, Benjamin Cummings Publishing. Company.
3. Ramakrishnan: Database Management System , McGraw-Hill
4. Gray Jim and Reuter Address, “Transaction Processing : Concepts and Techniques”, Moragan Kauffman Publishers.
5. Jain: Advanced Database Management System CyberTech
6. Date C. J., “Introduction to Database Management”, Vol. I, II, III, Addison Wesley.

7. Ullman JD., “Principles of Database Systems”, Galgottia Publication.
8. James Martin, “Principles of Database Management Systems”, 1985, Prentice Hall of India, New Delhi
9. “Fundamentals of Database Systems”, Ramez Elmasri, Shamkant B.Navathe, Addison Wesley Publishing Edition
10. “Database Management Systems”, Arun K.Majumdar, Pritimay Bhattacharya, Tata McGraw Hill

Course Code: PCC-CS591

Course Title: Database Management Systems Laboratory

Credit: 2

Structured Query Language

1. **Creating Database**

- Creating a Database
- Creating a Table
- Specifying Relational Data Types
- Specifying Constraints
- Creating Indexes

Table and Record Handling

1. INSERT statement
2. Using SELECT and INSERT together
3. DELETE, UPDATE, TRUNCATE statements
4. DROP, ALTER statements

Retrieving Data from a Database

- The SELECT statement
- Using the WHERE clause
- Using Logical Operators in the WHERE clause
- Using IN, BETWEEN, LIKE , ORDER BY, GROUP BY and HAVING Clause
- Using Aggregate Functions
- Combining Tables Using JOINS
- Subqueries

Database Management

- Creating Views
- Creating Column Aliases
- Creating Database Users
- Using GRANT and REVOKE

Basics of PL/SQL & its implementations

Course Code: PCC-CS502

Course Title: Formal Language & Automata Theory

Credit: 3

1 Regular Languages and Finite Automata:

Deterministic finite automata (DFA) and Nondeterministic finite automata (NFA) NFA to DFA Conversion(with and without null moves), Equivalence of Finite State Machines, Minimization of Finite Automata, Moore and Mealy Machine, Merger Table, Merger Graph, Compatibility Graph, Finite memory definiteness, Testing Table Testing Graph, Introduction to Regular expressions. Conversion of Finite Automata to Regular Expression and Vice Versa. Regular grammars and equivalence with finite automata (Inter-conversion), Closure properties of regular languages, pumping lemma for regular languages. 12

2 Grammar:

Chomsky hierarchy of languages/Grammar. Introduction to Grammar. Construction of Grammar for a given language.

Context Free Grammar: Parse Tree, Derivation of Strings from Grammar, Ambiguity of Grammar, Removal of Ambiguity, Simplification of Context Free Grammar, CNF and GNF. 8

3 Pushdown automata and Context Free Language:

Deterministic and Non-deterministic pushdown automata (PDA) and equivalence with CFG, Acceptance of CFL by PDA (2 types). pumping lemma for context-free languages, Closure properties of CFLs. Relation of PDA and Parsing. Brief Introduction to Linear Bounded Automata (LBA) 10

4 Turing machines:

The basic model for Turing machines (TM), TM Design, Turing recognizable(recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, Church-Turing thesis, Universal Turing machine, Halting Problem. Decidability and Un-decidability. 10

Learning Resources:

1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata

Theory, Languages, and Computation, Pearson Education Asia.

2. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation,

Pearson Education Asia.

3. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer

Science, Springer.

4. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.

5. John Martin, Introduction to Languages and The Theory of Computation, TataMcGraw

Hill., PEARSON.

6. Dr. R.B.Patel, Theory of Computation, Khanna Publishing House

Course Code: PCC-CS503

Course Title: Object Oriented Programming

Credit: 2

1 Introduction to Object-Oriented Thinking

- Difference between OOP and other conventional programming – advantages and disadvantages
- Class, object, message passing,
- encapsulation,
- inheritance,

- polymorphism
- Software Design
- Software Development Life Cycle 2

2 Object-Oriented Programming Constructs

- Class, Object,
- relationships among classes- association, dependency (use, call), aggregation, grouping, generalisation
- relationships among objects - instantiation, links
- meta-class
- Modelling with UML Class and Sequence Diagrams9

3 Designing for Reuse

- Good design principles e.g. Single Responsibility Principle (SRP). Don't Repeat Yourself (DRY) Principle.
- Interfaces and abstract classes.
- Loose coupling.
- Inheritance versus Delegation.

4 Basic concepts of Java programming

Advantages of Java, byte-code & JVM, data types, access specifiers, operators, control statements & loops, for-each loop, array, creation of class, object, constructor, object class, finalize and garbage collection, use of method overloading, this keyword, use of objects as parameter & methods returning objects, call by value & call by reference, variable length arguments, static block, variables & methods, nested & inner classes.

String Classes

String class, concept of string pool, concept of mutable and immutable string, basic methods of String class, StringBuffer class, basic methods of StringBuffer class, Introduction to StringBuilder class, basic methods of StringBuilder class, comparisons.

Basic of I/O operations

Command line argument, basic of I/O, different types of streams, basic stream classes, introduction to BufferedReader class, basic file handling, introduction to Scanner class.

5 Reusability properties

Super class & subclasses including multilevel hierarchy, process of constructor calling in inheritance, use of super and final keywords comparison between super and this, dynamic method dispatch, method hiding, object type casting, use of abstract classes & methods, interfaces.

Package

Introduction to package concept, Advantage of using package concept, basic inbuilt packages, package creation, different ways of importing packages, member access for packages

6 Exception handling

Exception handling basics, different types of exception classes, use of try & catch with throw, throws & finally, try with resources, creation of user defined exception classes.

Threading

Introduction to process, scheduling, context switching, difference between process and thread, basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread priorities, thread synchronization, inter-thread communication, deadlocks for threads, suspending & resuming threads.

Swing

Advanced Topics: Basic concepts of AWT library, Creation of GUI using Swing library, Event Driven Programming (implementing ActionListener to multiple buttons, MouseListener, KeyListener interfaces), Painting (drawing objects) using AWT.

Generic class and Collection framework

Introduction to generic class, advantage of generic class user defined generic class & method, introduction to collection framework, advantages, different classes, iterator.

Course Code: PCC-CS593

Course Title: Object Oriented Programming Laboratory

Credit: 2

1. Assignments on class, constructor, overloading, inheritance, overriding
2. Assignments on wrapper class, arrays
3. Assignments on developing interfaces- multiple inheritance, extending interfaces
4. Assignments on creating and accessing packages
5. Assignments on multithreaded programming
6. Assignments on applet programming

Note: Use Java for programming

Preferably download "**java_ee_sdk-6u4-jdk7-windows.exe**" from

http://www.oracle.com/technetwork/java/javaee/downloads/java-ee-sdk-6u3-jdk-7u1-downloads-523391.html

Course Code: PCC-CS504
Course Title: Software Engineering
Credit: 2

1 Software Engineering –Objectives, Definitions ,Software Process models - Waterfall Model , Prototype model, RAD, Evolutionary Models ,Incremental, Spiral

Software Project Planning- Feasibility Analysis, Technical Feasibility, Cost- Benefit Analysis, COCOMO model. 8

2 Structured Analysis , Context diagram and DFD, Physical and Logical DFDs ,Data Modelling, ER diagrams, Software Requirements Specification

3 Design Aspects :Top-Down And Bottom-Up design; Decision tree, decision table and structured English, Structure chart, Transform analysis Functional vs. Object- Oriented approach. 4

4 Unified Modelling Language

Class diagram, interaction diagram: collaboration diagram, sequence diagram, state chart diagram, activity diagram, implementation diagram

5 Coding & Documentation – Structured Programming, Modular Programming, Module Relationship-Coupling, Cohesion, OO Programming, Information Hiding, Reuse, System Documentation.

Testing – Levels of Testing, Integration Testing, System Testing.

Software Quality, Quality Assurance, Software Maintenance, Software Configuration Management, Software Architecture.

Learning Resources:

1. Software Engineering : A practitioner's approach– Pressman(TMH)
2. Software Engineering- Pankaj Jalote (Wiley-India)
3. Software Engineering- Rajib Mall (PHI)
4. Software Engineering –Agarwal and Agarwal (PHI)

Course Code: PCC-CS594
Course Title: Software Engineering Laboratory
Credit: 2

Part-A: Basics of C++ using OOPs concept, implementation of inheritance, polymorphism, friend function, perform various kind of effort estimation, solving of function point metrices.

Part-B: Development of requirements specification, function-oriented design using SA/SD, object-oriented design using UML, test case design, implementation of CRUD based project using C++ (along with file management system or database management system) and testing. Use of appropriate CASE tools and other tools such as configuration management tools, program analysis tools in the software life cycle.

References

1. Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India.
2. Pankaj Jalote, An integrated approach to Software Engineering, Springer/Narosa.
3. Roger S. Pressman, Software Engineering: A practitioner's approach, McGraw Hill.
4. Ian Sommerville, Software Engineering, Addison-Wesley.

Course Code: HSMC501
Course Title: Humanities – II (Principles of Management)
Credit: 3

Basic concepts of management: Definition – Essence, Functions, Roles, Level.
Functions of Management: Planning – Concept, Nature, Types, Analysis, Management by objectives; Organisation Structure – Concept, Structure, Principles, Centralization, Decentralization, Span of Management; Organisational Effectiveness.
Management and Society – Concept, External Environment, CSR, Corporate Governance, Ethical Standards.
People Management – Overview, Job design, Recruitment & Selection, Training & Development, Stress Management.
Managerial Competencies – Communication, Motivation, Team Effectiveness, Conflict Management, Creativity, Entrepreneurship.
Leadership: Concept, Nature, Styles.
Decision making: Concept, Nature, Process, Tools & techniques.
Economic, Financial & Quantitative Analysis – Production, Markets, National Income Accounting, Financial Function & Goals, Financial Statement & Ratio Analysis, Quantitative Methods – Statistical Interference, Forecasting, Regression Analysis, Statistical Quality Control.
Customer Management – Market Planning & Research, Marketing Mix, Advertising & Brand Management.
Operations & Technology Management – Production & Operations Management, Logistics & Supply Chain Management, TQM, Kaizen & Six Sigma, MIS.

Course Code: PEC-CS501
Course Title: Professional Elective - I

Credit: 3

Refer to Page No –

Course Code: MC501
Course Title: Constitution of India & Essence of Indian Knowledge Tradition
Credit: 0

Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

Union government and its administration: Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha. State government and its administration: Governor: Role and Position, CM and Council of ministers, State Secretariat: Organisation, Structure and Functions.

Supreme court: Organization of supreme court, procedure of the court, independence of the court, jurisdiction and power of supreme court. High court: Organization of high court, procedure of the court, independence of the court, jurisdiction and power of supreme court. Subordinate courts: constitutional provision, structure and jurisdiction. National legal services authority, Lok adalats, family courts, gram nyayalays. Public interest litigation (PIL): meaning of PIL, features of PIL, scope of PIL, principle of PIL, guidelines for admitting PIL

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Learning Resources:

1. Indian polity, M, Laxmikanth, MC Graw Hill education, 5th Edition.

2. DD Basu, "Introduction to the constitution of India", 21st Edition, Lexis Nexis Books Publication ltd, India

Course Code: MC581
Course Title: Mandatory Additional Requirements (MAR)
Credit: 0

Course Code: HSMC502
Course Title: Universal Human Values - V

Credit: 3

Course Code: PROJ-CS501
Course Title: Innovative Project - III
Credit: 1

Course Code: MOOC 5
Course Title: Massive Open Online Courses (Mandatory for B.Tech (Honours))
Credit: 2

B.Tech 3rd Year 6th Semester

Course Code: PCC-CS601
Course Title: Compiler Design
Credit: 3

Module I
Introduction to Compiling [2L]
Compilers, Analysis-synthesis model , The phases of the compiler, Cousins of the compiler.
Lexical Analysis [5L]
The role of the lexical analyzer, Tokens, Patterns, Lexemes, Input buffering, Specifications of a token, Recognition of tokens, Finite automata, From a regular expression to an NFA, From a regular expression to NFA, From a regular expression to DFA, Design of a lexical analyzer generator (Lex).

Module II
Syntax Analysis [8L]
The role of a parser, Context free grammars, Writing a grammar, Top down Parsing, Non-recursive Predictive parsing (LL), Bottom up parsing, Handles, Viable prefixes, Operator precedence parsing, LR parsers (SLR, LALR), Parser generators (YACC). Error Recovery strategies for different parsing techniques.
Syntax directed translation [4L]
Syntax directed definitions, Construction of syntax trees, Bottom-up evaluation of S attributed definitions, L attributed definitions, Bottom-up evaluation of inherited attributes.

Module III
Type checking [3L]
Type systems, Specification of a simple type checker, Equivalence of type expressions, Type conversions
Run time environments [4L]
Source language issues (Activation trees, Control stack, scope of declaration, Binding of names), Storage organization (Subdivision of run-time memory, Activation records), Storage allocation strategies, Parameter passing (call by value, call by reference, copy restore, call by name), Symbol tables, dynamic storage allocation techniques.

Module IV

Intermediate code generation [3L]

Intermediate languages, Graphical representation, Three-address code, Implementation of three address statements (Quadruples, Triples, Indirect triples).

Code optimization [4L]

Introduction, Basic blocks & flow graphs, Transformation of basic blocks, Dag representation of basic blocks, The principle sources of optimization, Loops in flow graph, Peephole optimization.

Code generations [3L]

Issues in the design of code generator, a simple code generator, Register allocation & assignment.

Learning Resources:

1. Aho, Sethi, Ullman - "Compiler Principles, Techniques and Tools" - Pearson Education.
2. Holub - "Compiler Design in C" – PHI
3.Tremblay and Sorenson Compiler Writing-McgrawHill International .
4. Chattopadhyay , S- Compiler Design (PHI)

Course Code: PCC-CS691
Course Title: Compiler Design Laboratory
Credit: 2

1. Implementation of Symbol Table
2. Develop a lexical analyzer to recognize a few patterns in C. (Ex. identifiers, constants, comments, operators etc.)
3. Implementation of Lexical Analyzer using Lex Tool
4. Generate YACC specification for a few syntactic categories.
a) Program to recognize a valid arithmetic expression that uses operator +, – , * and /.
b) Program to recognize a valid variable which starts with a letter followed by any number of letters or digits.
c)Implementation of Calculator using LEX and YACC
5. Convert the BNF rules into Yacc form and write code to generate Abstract Syntax Tree.
6. Implement type checking
7. Implement control flow analysis and Data flow Analysis
8. Implement any one storage allocation strategies(Heap,Stack,Static)
9. Construction of DAG
10. Implement the back end of the compiler which takes the three address code and produces the 8086 assembly language instructions that can be assembled and run using a 8086 assembler. The target assembly instructions can be simple move, add, sub, jump. Also simple addressing modes are used.

Course Code: PCC-CS602
Course Title: Computer Networks
Credit: 3

1 Module I

Overview of Data Communication and Networking:

Introduction; Data communications: components, data representation (ASCII,ISO etc.), direction of data flow (simplex, half duplex, full duplex); network criteria, physical structure (type of connection, topology), categories of network (LAN, MAN,WAN); Internet: brief history, Protocols and standards; Reference models: OSI reference model, TCP/IP reference model, their comparative study.

Physical Level:

Overview of data(analog & digital), signal(analog & digital), transmission (analog & digital) & transmission media (guided & unguided); Circuit switching: time division & space division switch, TDM bus; Telephone Network;

2 Module II

Data link Layer:

Types of errors, framing(character and bit stuffing), error detection & correction methods; Flow control; Protocols: Stop & wait ARQ, Go-Back- N ARQ, Selective repeat ARQ, HDLC;

Medium Access sub layer:

Point to Point Protocol, LCP, NCP, Token Ring; Reservation, Polling, Multiple access protocols: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA Traditional Ethernet, fast Ethernet(in brief);

3 Module III

Network layer:

Internetworking & devices: Repeaters, Hubs, Bridges, Switches, Router, Gateway; Addressing : IP addressing, subnetting; Routing : techniques, static vs. dynamic routing , Unicast Routing Protocols: RIP, OSPF, BGP; Other Procols: ARP, IP, ICMP, IPV6;.

Transport layer:

Process to Process delivery; UDP; TCP; Congestion Control: Open Loop, Closed Loop choke packets; Quality of service: techniques to improve QoS: Leaky bucket algorithm, Token bucket algorithm, 10

4 Application Layer

Introduction to DNS, SMTP, SNMP, FTP, HTTP & WWW; Security: Cryptography (Public, Private Key based), Digital Signature, Firewalls.

Modern topics:

ISDN services & ATM, DSL technology, Cable Modem: Architecture & Operation in brief

Wireless LAN: IEEE 802.11, Introduction to blue-tooth.

Learning Resources:

1. B. A. Forouzan – "Data Communications and Networking (3rd Ed.) " – TMH
2. A. S. Tanenbaum – "Computer Networks (4th Ed.)" – Pearson Education/PHI
3. W. Stallings – "Data and Computer Communications (5th Ed.)" – PHI/ Pearson Education
4. Zheng & Akhtar, Network for Computer Scientists & Engineers, OUP
5. Black, Data & Computer Communication, PHI
6. Miller, data Communication & Network, Vikas
7. Miller, Digital & Data Communication, Jaico
8. Shay, Understanding Data Communication & Network, Vikas
9. Kurose and Rose – " Computer Networking -A top down approach featuring the internet" – Pearson Education
10. Leon, Garica, Widjaja – "Communication Networks" – TMH
11. Walrand – "Communication Networks" – TMH.
12. Comer – "Internetworking with TCP/IP, vol. 1, 2, 3(4th Ed.)" – Pearson Education/PHI

Course Code: PCC-CS692
Course Title: Computer Networks Laboratory
Credit: 2

Description

- IPC (Message queue)
- NIC Installation & Configuration (Windows/Linux)
- Familiarization with
    - Networking cables (CAT5, UTP)
    - Connectors (RJ45, T-connector)
    - Hubs, Switches

- TCP/UDP Socket Programming
- Multicast & Broadcast Sockets

Implementation of a Prototype Multithreaded Server

- Implementation of
    - Data Link Layer Flow Control Mechanism (Stop & Wait, Sliding Window)
    - Data Link Layer Error Detection Mechanism (Cyclic Redundancy Check)
    - Data Link Layer Error Control Mechanism (Selective Repeat, Go Back N)

Course Code: PCC-CS603
Course Title: Cloud Computing & IoT
Credit: 2

1 Definition of Cloud Computing:

Defining a Cloud, Cloud Types – NIST model, Cloud Cube model, Deployment models (Public , Private, Hybrid and Community Clouds), Service models – Infrastructure as a Service, Platform as a Service, Software as a Service with examples of services/ service providers, Cloud Reference model
Characteristics of Cloud Computing – a shift in paradigm
Benefits and advantages of Cloud Computing

2 A brief introduction on Composability, Infrastructure, Platforms, Virtual Appliances, Communication Protocols, Applications, Connecting to the Cloud by Clients

3 IaaS – Basic concept, Workload, partitioning of virtual private server instances, Pods, aggregations, silos
PaaS – Basic concept, tools and development environment with examples
SaaS - Basic concept and characteristics, Open SaaS and SOA, examples of SaaS platform
Identity as a Service (IDaaS)
Compliance as a Service (CaaS)

4 Concepts of Abstraction and Virtualization
Virtualization technologies : Types of virtualization (access, application, CPU, storage), Mobility patterns (P2V, V2V, V2P, P2P, D2C, C2C, C2D, D2D)

5 Load Balancing and Virtualization: Basic Concepts, Network resources for load balancing, Advanced load balancing (including Application Delivery Controller and Application Delivery Network), Mention of The Google Cloud as an example of use of load balancing
Hypervisors: Virtual machine technology and types, VMware vSphere
Machine Imaging (including mention of Open Virtualization Format – OVF)

6 Porting of applications in the Cloud: The simple Cloud API and AppZero Virtual Application appliance
7 Definition of services, Distinction between SaaS and PaaS (knowledge of Salesforce.com and Force.com), Application development
Use of PaaS Application frameworks
8 Use of Google Web Services
Discussion of Google Applications Portfolio – Indexed search, Dark Web, Aggregation and disintermediation, Productivity applications and service, Adwords, Google Analytics, Google Translate, a brief discussion on Google Toolkit (including introduction of Google APIs in brief), major features of Google App Engine service.
Use of Amazon Web Services
Amazon Web Service components and services: Amazon Elastic Cloud, Amazon Simple Storage system, Amazon Elastic Block Store, Amazon SimpleDB and Relational Database Service

Use of Microsoft Cloud Services
Windows Azure platform: Microsoft's approach, architecture, and main elements, overview of Windows Azure AppFabric, Content Delivery Network, SQL Azure, and Windows Live services

9 Cloud Management
An overview of the features of network management systems and a brief introduction of related products from large cloud vendors, Monitoring of an entire cloud computing deployment stack – an overview with mention of some products, Lifecycle management of cloud services (six stages of lifecycle)
Concepts of Cloud Security
Cloud security concerns, Security boundary, Security service boundary
Overview of security mapping

Security of data: Brokered cloud storage access, Storage location and tenancy, encryption, and auditing and compliance
Identity management (awareness of Identity protocol standards)

10 Service Oriented Architecture: Basic concepts of message-based transactions, Protocol stack for an SOA architecture, Event-driven SOA, Enterprise Service Bus, Service catalogs
Applications in the Cloud: Concepts of cloud transactions, functionality mapping, Application attributes, Cloud service attributes, System abstraction and Cloud Bursting, Applications and Cloud APIs
Cloud-based Storage: Cloud storage definition – Manned and Unmanned
Webmail Services: Cloud mail services including Google Gmail, Mail2Web, Windows Live Hotmail, Yahoo mail, concepts of Syndication services

Course Code: PCC-CS693
Course Title: Cloud Computing & IoT Laboratory
Credit: 1

1. Creating a Warehouse Application in SalesForce.com.
2. Creating an Application in SalesForce.com using Apexprogramming Language.
3. Implementation of SOAP Web services in C#/JAVAApplications.
4. Implementation of Para-Virtualization using VM Ware‘sWorkstation/ Oracle‘s Virtual Box and Guest O.S.
5. Installation and Configuration of Hadoop.
6. Create an application (Ex: Word Count) using HadoopMap/Reduce.
7. Case Study: PAAS(Facebook, Google App Engine)
8. Case Study: Amazon Web Services.
9. Recapitulation of Python.
10. Study and Install IDE of Arduino and different types of Arduino.
11. Write program using Arduino IDE for Blink LED.
12. Write Program for RGB LED using Arduino.
13. Study the Temperature sensor and Write Program foe monitor temperature usingArduino.
14. Study and Implement RFID, NFC using Arduino.
15. Study and implement MQTT protocol using Arduino.
16. Study and Configure Raspberry Pi.
17. WAP for LED blink using Raspberry Pi.
18. Study and Implement Zigbee Protocol using Arduino / Raspberry Pi.

Course Code: PEC-CS601
Course Title: Professional Elective -II
Credit: 3

Course Code: PEC-CS602
Course Title: Professional Elective -III
Credit: 3

Course Code: OEC-CS601

Course Title: Open Elective -I
Credit: 3

Course Code: PROJ-CS601
Course Title: Project - I
Credit: 3

Course Code: HSMC602
Course Title: Universal Human Values - VI
Credit: 2

Course Code: MC681
Course Title: Mandatory Additional Requirements (MAR)
Credit: 0

Course Code: MOOC 6
Course Title: Massive Open Online Courses (Mandatory for B.Tech (Honours))
Credit: 1.5

B.Tech 4th Year 7th Semester

Course Code: PCC-CS701
Course Title: Network Security & Cryptography
Credit: 2

1. Introduction and Mathematical Foundations

Introduction to cryptography, Overview on Modern Cryptography, Number Theory, Probability and Information Theory

2. **Classical Cryptosystems**

Cryptanalysis of Classical Cryptosystems
Shannon's Theory: I
Shannon's Theory: II
Shannon's Theory: III

3.**Symmetric Key Ciphers**

Modern Block Ciphers (DES)
Modern Block Cipher (AES)

Modern Block Cipher (AES) contd.

3.**Cryptanalysis of Symmetric Key Ciphers**
Linear Cryptanalysis
Differential Cryptanalysis
Other Cryptanalytic Techniques
Overview on S-Box Design Principles
Modes of operation of Block Ciphers

4.**Stream Ciphers and Pseudorandomness**
Stream Ciphers
Pseudorandom functions

5.Hash Functions and MACs Hash functions:
The Merkle Damgard Construction
Message Authentication Codes (MACs)

6.**Asymmetric Key Ciphers:**
Construction and Cryptanalysis
More Number Theoretic Results
The RSA Cryptosystem
Primality Testing
Factoring Algorithms
Other attacks on RSA and Semantic Security of RSA
The Discrete Logarithm Problem (DLP) and the Diffie Hellman Key Exchange algorithm
The ElGamal Encryption Algorithm
Cryptanalysis of DLP

7.**Digital Signatures**
Signature schemes: I
Signature schemes: II

8.**Modern Trends in Asymmetric Key Cryptography**
Elliptic curve based cryptography: I
Elliptic curve based cryptography: II

9.**Network Security Secret Sharing Schemes**
A Tutorial on Network Protocols, Kerberos
Pretty Good Privacy (PGP)
Secure Socket Layer (SSL)
Intruders and Viruses
Firewalls

Course Code: PEC-CS701
Course Title: Professional Elective - IV
Credit: 3

Course Code: PEC-CS702
Course Title: Professional Elective - V
Credit: 3

Course Code: OEC-CS701
Course Title: Open Elective - II
Credit: 3

Course Code: PROJ-CS701
Course Title: Project - II
Credit: 6

Course Code: HSMC702
Course Title: Universal Human Values - VII
Credit: 3

Course Code: MC781
Course Title: Mandatory Additional Requirements (MAR)
Credit: 0

Course Code: MOOC 7
Course Title: Massive Open Online Courses (Mandatory for B.Tech (Honours))
Credit: 5

B.Tech 4th Year 8th Semester

Course Code: PEC-CS801
Course Title: Professional Elective - VI
Credit: 3

Course Code: OEC-CS801
Course Title: Open Elective - III
Credit: 3

Course Code: OEC-CS802
Course Title: Open Elective - IV
Credit: 3

Course Code: PROJ-CS801
Course Title: Project - III
Credit: 6

Course Code: HSMC802
Course Title: Universal Human Values - VIII
Credit: 3

Course Code: PCC-CS881
Course Title: Grand Viva-Voce
Credit: 2

Course Code: MC881
Course Title: Mandatory Additional Requirements (MAR)
Credit: 0

Course Code: MOOC 8
Course Title: Massive Open Online Courses (Mandatory for B.Tech (Honours))
Credit: 5

Professional Elective – I
Option – 1. Neural Networks and Deep Learning

1.Fundamentals of Neural Network & Deep Learning:
Challenges in shallow network; Motivation for deep neural network, Different deep neural network architectures – Perceptron, Feedforward network, etc. Forward and backward propagation, Gradient Descent and related problems, Regularization, Batch normalization, Optimization algorithms (Adam's, RMSprop, etc.), Hyperparameters

2.Convolutional Neural Network:

Foundational concepts of CNN,Building a CNN architecture,Popular CNN architectures – LeNet, AlexNet, ResNet, CNN applications

3. Recurrent Neural Network:
Sequence data,Architecture of RNN,Long Short Term Memory (LSTM),Bi-directional LSTM,Gated Recurrent Unit (GRU),Applications of RNN

4.Important deep learning frameworks:
Tensorflow 2.0, Keras,PyTorch,Theano,Caffe

Learning Resources:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach, Deep Learning, The MIT Press.

2. Fundamentals of Deep Learning – by Nikhil Buduma (O'Reilly).

3. Deep Learning – A practitioner's approach – by Josh Patterson & Adam Gibson (O'Reilly).

Option – 2. Cybersecurity

Introduction to Cyber Space
History of Internet , Cyber Crime , Information Security , Computer Ethics and Security Policies
Choosing the Best Browser according to the requirement and email security:
Guidelines to choose web browsers , Securing web browser, Antivirus, Email security

Guidelines for secure password and wi-fi security
Guidelines for setting up a Secure password
Two-steps authentication
Password Manager
Wi-Fi Security

Guidelines for social media and basic Windows security
Guidelines for social media security
Tips and best practices for safer Social Networking
Basic Security for Windows
User Account Password

Smartphone security guidelines
Introduction to mobile phones
Smartphone Security , Android Security
IOS Security

Cyber Security Initiatives in India
Counter Cyber Security Initiatives in India
Cyber Security Exercise

Cyber Security Incident Handling
Cyber Security Assurance

Online Banking, Credit Card and UPI Security
Online Banking Security
Mobile Banking Security
Security of Debit and Credit Card
UPI Security

Micro ATM, e-wallet and POS Security
Security of Micro ATMs
e-wallet Security Guidelines
Security Guidelines for Point of Sales(POS)

Social Engineering
Social Engineering
Types of Social Engineering
How Cyber Criminal Works
How to prevent for being a victim of Cyber Crime

Cyber Security Threat Landscape and Techniques
Cyber Security Threat Landscape
Emerging Cyber Security Threats
Cyber Security Techniques
Firewall

IT Security Act and Misc. Topics
IT Act
Hackers-Attacker-Countermeasures
Web Application Security
Digital Infrastructure Security
Defensive Programming

Information Destroying and Recovery Tools
Recovering from Information Loss
Destroying Sensitive Information
CCleaner for Windows

Books and references

1 Introduction to Cyber Security available at http://uou.ac.in/foundation-course
2. Fundamentals of Information Security http://uou.ac.in/progdetail?pid=CEGCS-17
3. Cyber Security Techniques http://uou.ac.in/progdetail?pid=CEGCS-17
4. Cyber Attacks and Counter Measures: User Perspective http://uou.ac.in/progdetail?pid=CEGCS-17
5. Information System http://uou.ac.in/progdetail?pid=CEGCS-17

Professional Elective – II
Option 1. Soft computing:

1 Introduction to Soft Computing

- Concept of computing systems.
- "Soft" compiting versus "Hard" computing
- Characteristics of Soft computing
- Some applications of Soft computing techniques 4

2 Fuzzy logic

- Introduction to Fuzzy logic.
- Fuzzy sets and membership functions.
- Operations on Fuzzy sets.
- Fuzzy relations, rules, propositions, implications and inferences.
- Defuzzification techniques.
- Fuzzy logic controller design.
- Some applications of Fuzzy logic. 4

3 Genetic Algorithms

- Concept of "Genetics" and "Evolution" and its application to proablistic search techniques
- Basic GA framework and different GA architectures.
- GA operators: Encoding, Crossover, Selection, Mutation, etc.
- Solving single-objective optimization problems using GAs.

6

4 Multi-objective Optimization Problem Solving

- Concept of multi-objective optimization problems (MOOPs) and issues of solving them.
- Multi-Objective Evolutionary Algorithm (MOEA).
- Non-Pareto approaches to solve MOOPs
- Pareto-based approaches to solve MOOPs
- Some applications with MOEAs. 6

5 Artificial Neural Networks

- Biological neurons and its working.
- Simulation of biolgical neurons to problem soloving.
- Different ANNs architectures.
- Trainging techniques for ANNs.
- Applications of ANNs to solve some real life problems. 6

Learning Resources:

1. Fuzzy Logic: A Pratical approach, F. Martin, , Mc neill, and Ellen Thro, AP Professional, 2000.
2. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey, 2010.
3. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998.
4. Fuzzy Logic for Embedded Systems Applications, Ahmed M. Ibrahim, Elesvier Press, 2004.
5. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, 2000.
6. Genetic Algorithms In Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education, 2002.
7. Practical Genetic Algorithms, Randy L. Haupt and sue Ellen Haupt, John Willey & Sons, 2002.
8. Neural Networks, Fuzzy Logis and Genetic Algorithms : Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India, 2007.
9. Soft Computing, D. K. Pratihar, Narosa, 2008.
10. Neuro-Fuzzy and soft Computing, J.-S. R. Jang, C.-T. Sun, and E. Mizutani, PHI Learning, 2009.
11. Neural Networks and Learning Machines, (3rd Edn.), Simon Haykin, PHI Learning, 2011.

Option 2. Human Computer Interaction

Unit 1: Introduction to Human Computer Interface

Importance of User Interface, History of Human Computer Interface, Importance of Good Design, Benefits of Good Design, Principles of User Interface Design.

Unit 2: Interaction Devices

Keyboard Keys, Function Keys, Pointing Devices, Speech Recognition, Handwriting Recognition, Speech Generation, Image Display, Video Display, Device Drivers.

Unit 3: Color and Content

Why Colors, Color Uses, Choosing Colors, Possible Problems With Colors, Page Title, Headings, Text, Messages, Error Messages, Icons.

Unit 4: User Interface Design Process-I

Understanding How User Interact With Computers, User Interface Models, Design Methodologies, Designing an Interface, Process of Interaction Design.

Unit 5: User Interface Design Process-II

Human Interaction with Computers, Human Interaction Speeds, Human Characteristics in Design, Human Consideration in Design.

Unit 6: Graphical User Interface

Popularity of Graphics, Characteristics of Graphical User Interface, Concepts of Direct Manipulation, Graphical System Advantages and Disadvantages, Web User Interface Characteristics and Popularity.

Unit 7: Device and Screen-Based Control

Device Based Controls, Operable Controls, Text Entry/Read-Only Controls, Selection Controls, Combining Entry/Selection Controls, Other Operable Controls, Presentation Controls and Selecting Proper Controls

Unit 8: Screen Design

Design Goals, Test for a Good Design, Screen and Web Page Meaning and Purpose, Organizing Screen Elements Clearly, Ordering of Screen Data and Content, Screen Navigation and Flow.

Unit 9: Windows

Window characteristics, Components of Window, Window Presentation Styles, Types of Windows, Window Management.

Unit 10: Understanding Business Functions

Business Definitions and Requirement analysis, Determining Business Functions, Design Standards or Style Guides, System Training and Documentation.

Unit 11: Software Tools Specification Methods, Interface Building Tools-Interface Mock Up Tools, Software Engineering Tools, Windowing System Layer, GUI Tool Kit Layer.

Unit 12: Information Search and Visualization

Database Query, Phase Search in Documents, Multimedia Document Searches, Information Visualization, Advanced Filtering, Hypertext, Web Technology, Static Web Content and Dynamic Web Content.

Unit 13: Time

Response Time, Dealing With Time Delays, Echo Delay, File Delay, Blinking for Attention, Use of Sound, Preventing Errors

Unit 14: Usability and Prototypes

Usability: Purpose of Usability, Importance of Usability, Usability Testing.

Prototypes: Hand Sketches and Scenarios, Interactive Paper Prototypes, ProgrammFacades, Prototype-Oriented Languages, Comparisons of Prototypes.

Professional Elective – III
Option 1.

Data Analytics
1. Descriptive Statistics Introduction to the course Descriptive Statistics Probability Distributions

2. Inferential Statistics Inferential Statistics through hypothesis tests Permutation & Randomization Test 3. Regression & ANOVA Regression ANOVA (Analysis of Variance)

4. Machine Learning: Introduction and Concepts Differentiating algorithmic and model based frameworks Regression : Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbours Regression & Classification

5. Supervised Learning with Regression and Classification techniques -1 Bias-Variance Dichotomy NPTEL http://nptel.ac.in Management Pre-requisites: This course requires that you are familiar with high-school level linear algebra, and calculus.Knowledge of probability theory, statistics, and programming is desirable. Coordinators: Dr. Balaraman Ravindran Department of Computer Science and EngineeringIIT Madras Dr. Nandan Sudarsanam Department of Management StudiesIIT Madras Model Validation Approaches Logistic Regression Linear DiscriminantAnalysis Quadratic DiscriminantAnalysis Regression and Classification Trees Support Vector Machines

6. Supervised Learning with Regression and Classification techniques -2 Ensemble Methods: Random Forest Neural Networks Deep learning

7. Unsupervised Learning and Challenges for Big Data Analytics Clustering Associative Rule Mining Challenges for big data anlalytics

8. Prescriptive analytics Creating data for analytics through designed experiments Creating data for analytics through Active learning Creating data for analytics through Reinforcement learning

Option 2.

1.Introduction: Need for Distributed Record Keeping, Modeling faults and adversaries,Byzantine Generals problem,Consensus algorithms and their scalability problems,Why Nakamoto Came up with Blockchain based cryptocurrency? Technologies Borrowed in Blockchain – hash pointers, consensus, byzantine fault-tolerant distributed computing, digital cash etc.

2. Basic Distributed Computing: Atomic Broadcast, Consensus, Byzantine Models of fault tolerance

3. Basic Crypto primitives:
Hash functions, Puzzle friendly Hash, Collison resistant hash, digital signatures, public key crypto, verifiable random functions, Zero-knowledge systems.

4. Blockchain 1.0:
Bitcoin blockchain, the challenges, and solutions, proof of work, Proof of stake, alternatives to Bitcoin consensus, Bitcoin scripting language and their use.

5. Blockchain 2.0:
Ethereum and Smart Contracts, The Turing Completeness of Smart Contract Languages and verification challenges, Using smart contracts to enforce legal contracts, comparing Bitcoin scripting vs. Ethereum Smart Contracts.

6. Blockchain 3.0 :
Hyperledger fabric, the plug and play platform and mechanisms in permissioned blockchain
7. Privacy, Security issues in Blockchain: Blockchain:
Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains – such as Sybil attacks, selfish mining, 51% attacks - -advent of algorand, and Sharding based consensus algorithms to prevent these

Learning Resources:

1. Draft version of "S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, 'Blockchain Technology: Cryptocurrency and Applications', Oxford University Press, 2019.
2. Josh Thompson, 'Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing Platform, 2017.

Professional Elective – IV:

Option 1.

Speech and Natural Language Processing

1.Introduction: Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM – Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance

2.Word Level Analysis:
Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models

3.Syntactic Analysis:
Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures.

4.Semantics And Pragmatics : Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.

5.Discourse Analysis And Lexical Resources :
Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC).

Learning Resources:

1. Daniel Jurafsky, James H. Martin―Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.

2. Steven Bird, Ewan Klein and Edward Loper, ―Natural Language Processing with Python, First Edition, OReilly Media, 2009.

Option 2.

Embedded Systems

1. Core of the embedded system, Memory, Sensors (resistive, optical, position, thermal) and Actuators (solenoid valves, relay/switch, opto-couplers), Communication Interface, Embedded firmware (RTOS, Drivers, Application programs), Power-supply (Battery technology, Solar), PCB and Passive components, Safety and reliability, environmental issues. Ethical practice.
Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency.
Embedded Product development life cycle, Program modeling concepts: DFG, FSM, Petri-net, UML

2. Introduction to ARM-v7-M (Cortex-M3), ARM-v7-R (CortexR4) and comparison in between them. Introduction to ARM-v7-M (Cortex-M3), ARM-v7-R (CortexR4) and
comparison in between them.

3. Embedded Serial communication
Study of basic communication protocols like SPI, SCI (RS232, RS485), I2C, 10 CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor network

4. Real time operating system: POSIX Compliance , Need of RTOS in Embedded system software, Foreground/Background systems, multitasking, context switching, IPC, Scheduler policies, Architecture of kernel, task scheduler, ISR, Semaphores, mailbox, message queues, pipes, events, timers, memory management, RTOS services in contrast with traditional OS.

Learning Resources:

1. Introduction to Embedded Systems : Shibu K. V. (TMH)
2. Embedded System Design – A unified hardware and software introduction: F. Vahid (John Wiley)
3. Embedded Systems : Rajkamal (TMH)
4. Embedded Systems : L. B. Das (Pearson)

Professional Elective 5

Option 1.

Image Processing

Introduction [3L]
Background, Digital Image Representation, Fundamental steps in Image Processing, Elements of Digital Image Processing - Image Acquisition, Storage, Processing, Communication, Display.

Digital Image Formation [4L]
A Simple Image Model, Geometric Model- Basic Transformation (Translation, Scaling, Rotation), Perspective Projection, Sampling & Quantization - Uniform & Non uniform.

Mathematical Preliminaries [9L]
Neighbour of pixels, Connectivity, Relations, Equivalence & Transitive Closure; Distance Measures, Arithmetic/Logic Operations, Fourier Transformation, Properties of The Two Dimensional Fourier Transform, Discrete Fourier Transform, Discrete Cosine & Sine Transform.

Image Enhancement [8L]
Spatial Domain Method, Frequency Domain Method, Contrast Enhancement -Linear & Nonlinear Stretching, Histogram Processing; Smoothing - Image Averaging, Mean Filter, Low-pass Filtering; Image Sharpening. High-pass Filtering, High-boost Filtering, Derivative Filtering, Homomorphic Filtering; Enhancement in the frequency domain - Low pass filtering, High pass filtering.

Image Restoration [7L]
Degradation Model, Discrete Formulation, Algebraic Approach to Restoration - Unconstrained & Constrained; Constrained Least Square Restoration, Restoration by Homomorphic Filtering, Geometric Transformation - Spatial Transformation, Gray Level Interpolation.

Image Segmentation [7L]
Point Detection, Line Detection, Edge detection, Combined detection, Edge Linking & Boundary Detection - Local Processing, Global Processing via The Hough Transform; Thresholding - Foundation, Simple Global Thresholding, Optimal Thresholding; Region Oriented Segmentation - Basic Formulation, Region Growing by Pixel Aggregation, Region Splitting & Merging.

Books:

1. Digital Image Processing, Gonzalves,Pearson
2. Digital Image Processing, Jahne, Springer India
3.Digital Image Processing & Analysis,Chanda & Majumder,PHI
4.Fundamentals of Digital Image Processing, Jain, PHI
5.Image Processing, Analysis & Machine Vision, Sonka, VIKAS
6. Getting Started with GIS- Clarke Keith. C; PE.
7. Concepts & Techniques of GIS - Lo C.P, Albert, Yeung K.W- PHI.

Option 2. Digital Forensics

1.Computer forensics fundamentals, Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues.

2.Understanding Computing Investigations – Procedure for corporate High-Tech investigations, understanding data recovery work station and software, conducting and investigations.

3.Data acquisition- understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisitions tools.

4.Processing crimes and incident scenes, securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case.

5.Current computer forensics tools- software, hardware tools, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions, E-Mail investigations- investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool.

Learning Resources:

1. Warren G. Kruse II and Jay G. Heiser, "Computer Forensics: Incident Response Essentials", Addison Wesley, 2002.
2. Nelson, B, Phillips, A, Enfinger, F, Stuart, C., "Guide to Computer Forensics and Investigations, 2nd ed., Thomson Course Technology, 2006, ISBN: 0-619-21706-5.
3. Vacca, J, Computer Forensics, Computer Crime Scene Investigation, 2nd Ed, Charles River Media, 2005, ISBN: 1-58450-389.

Professional Elective – 6

Option 1. Quantum Computing

Module No	Module Details	Contact Hours
1	**Introduction to Quantum Computation:** Quantum bits, Bloch sphererepresentation of a qubit, multiple qubits.	2
2	**Background Mathematics and Physics:** Hilber space, Probabilities andmeasurements, entanglement, density operators and correlation, basics ofquantum mechanics, Measurements in bases other than computational basis.	8
3	**Quantum Circuits:** single qubit gates, multiple qubit gates, design of quantum circuits.	6
4	**Quantum Information and Cryptography:** Comparison between classical andquantum information theory. Bell states. Quantum teleportation. QuantumCryptography, no cloning theorem.	6
5	**Quantum Algorithms:** Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search.	10

6	**Noise and error correction:** Graph states and codes, Quantum error correction,fault-tolerant computation.	**10**

Suggested Books:

1. Nielsen M. A., **Quantum Computation and Quantum Information**,Cambridge University Press.
2. Benenti G., Casati G. and Strini G., **Principles of Quantum Computation and Information**, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific.
3. Pittenger A. O., **An Introduction to Quantum Computing Algorithms**

Option 2. Cyber Law , IPR & Ethics

1.Introduction to cyber law Evolution of computer Technology, emergence of cyber space. Cyber Jurisprudence, Jurisprudence and law, Doctrinal approach, Consensual approach, Real Approach, Cyber Ethics, Cyber Jurisdiction, Cyber Laws of other countries: EU GDPR, PIPEDA (Canada), etc.

2.Information technology Act Overview of IT Act, 2000, Amendments in 2008/2013 and Limitations of ITAct, Legal Recognition of Electronic Records, Legal Recognition of Digital Signature, Certifying Authorities, Cyber Crime and Offences, Network Service Providers Li- ability

3.Cyber law and related Legislation Patent Law, Trademark Law, Copyright, Software Copyright or Patented, Domain Names and Copyright disputes, Electronic Data Base and its Protection, IT Act and Civil Procedure Code, IT Act and Criminal Procedural Code, Relevant SectionsofIndianEvidenceAct,RelevantSectionsofBankersBookEvidence Act, Relevant Sections of Indian Penal Code, Relevant Sections of Reserve Bank ofIndiaAct,LawRelatingToEmployeesAndInternet,AlternativeDisputeResolution, Online Dispute Resolution (ODR).

4.Electronic Business and legal issues Legal issues in Evolution and development in E-commerce, paper vs paper less contracts E-Commerce models- B2B, B2C,E security

5.Application area Business, taxation, electronic payments, supply chain, EDI, E-markets, Emerging Trends

Learning Resources:

1.Cyber Law & Cyber Crimes By Advocat Prashant Mali; Snow White publications, Mumbai
2. Cyber Law in India by Farooq Ahmad; Pioneer Books
3. Information Technology Law and Practice by Vakul Sharma; Universal Law Publishing Co. Pvt. Ltd.
4. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
5. Guide to Cyber and E – Commerce Laws by P.M. Bukshi and R.K. Suri; Bharat Law

Recommended Open Elective Courses

Optional Elective Course 1.

Option 1 & 2. Human Resource Development and Organizational Behavior

1. Organizational Behaviour: Definition, Importance, Historical Background, Fundamental Concepts of OB, Challenges and Opportunities for OB. **[2]**
2. Personality and Attitudes: Meaning of personality, Personality Determinants and Traits, Development of Personality, Types of Attitudes, Job Satisfaction. **[2]**
3. Perception: Definition, Nature and Importance, Factors influencing Perception, Perceptual Selectivity, Link between Perception and Decision Making. **[2]**
4. Motivation: Definition, Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Y, Herzberg's Motivation-Hygiene Theory, Alderfer's ERG Theory, McClelland's Theory of Needs, Vroom's Expectancy Theory. **[4]**
5. Group Behaviour: Characteristics of Group, Types of Groups, Stages of Group Development, Group Decision Making. **[2]**
6. Communication: Communication Process, Direction of Communication, Barriers to Effective Communication. **[2]**
7. Leadership: Definition, Importance, Theories of Leadership Styles. **[2]**
8. Organizational Politics: Definition, Factors contributing to Political Behaviour. **[2]**
9. Conflict Management: Traditional vis-a-vis Modern View of Conflict, Functional and Dysfunctional Conflict, Conflict Process, Negotiation – Bargaining Strategies, Negotiation Process. **[2]**
10. Organizational Design: Various Organizational Structures and their Effects on Human Behaviour, Concepts of Organizational Climate and Organizational Culture. **[4]**

References:

Robbins, S. P. & Judge, T.A.: Organizational Behavior, Pearson Education, 15th Edn.

1. Luthans, Fred: Organizational Behavior, McGraw Hill, 12th Edn.
2. Shukla, Madhukar: Understanding Organizations – Organizational Theory & Practice in India, PHI
3. Fincham, R. & Rhodes, P.: Principles of Organizational Behaviour, OUP, 4th Edn.

Hersey, P., Blanchard, K.H., Johnson, D.E.- Management of Organizational Behavior Leading Human Resources, PHI, 10th Edn.

Optional Elective Course 2.

Option 1. Cyber Security

1. Introduction to Cyber Security

Overview of Cyber Security, Internet Governance – Challenges and Constraints, Cyber Threats:- Cyber Warfare-Cyber Crime-Cyber terrorism-Cyber Espionage, Need for a Comprehensive Cyber Security Policy, Need for a Nodal Authority, Need for an International convention on Cyberspace.

2.Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Access control, Audit, Authentication,

Biometrics, Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management.

3.Introduction, Basic security for HTTP Applications and Services, Basic Security for SOAP Services, Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges.

4.Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider, Malware infection, Intrusion detection and Prevention Techniques, Anti-Malware software, Network based Intrusion detection Systems, Network based Intrusion Prevention Systems, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation.

5.Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider, Malware infection, Intrusion detection and Prevention Techniques, Anti-Malware software, Network based Intrusion detection Systems, Network based Intrusion Prevention Systems, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation.

6.Cyberspace and the Law
Introduction, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyberspace, Cyber Security Standards. The INDIAN Cyberspace, National Cyber Security Policy 2013.

7.Cyber Forensics
Introduction to Cyber Forensics, Handling Preliminary Investigations, Controlling an Investigation, Conducting disk-based analysis, Investigating Information-hiding, Scrutinizing E-mail, Validating E-mail header information, Tracing Internet access, Tracing memory in real-time.

Learning Resources:

1. William Stallings and Lawrie Brown, “Computer Security: Principles and Practice”, Prentice Hall, 2008.

2. Joseph M Kizza, “Computer Network Security”, Springer Verlag, 2005

3. Thomas Calabres and Tom Calabrese, “Information Security Intelligence: Cryptographic Principles & Application”, Thomson Delmar Learning, 2004.

Option 2. Data Analytics

1. Descriptive Statistics Introduction to the course Descriptive Statistics Probability Distributions

2. Inferential Statistics Inferential Statistics through hypothesis tests Permutation & Randomization Test 3. Regression & ANOVA Regression ANOVA (Analysis of Variance)

4. Machine Learning: Introduction and Concepts Differentiating algorithmic and model based frameworks Regression : Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbours Regression & Classification

5. Supervised Learning with Regression and Classification techniques -1 Bias-Variance Dichotomy NPTEL http://nptel.ac.in Management Pre-requisites: This course requires that you are familiar with high-school level linear algebra, and calculus.Knowledge of probability theory, statistics, and programming is desirable. Coordinators: Dr. Balaraman Ravindran Department of Computer Science and EngineeringIIT Madras Dr. Nandan Sudarsanam Department of Management StudiesIIT Madras Model Validation Approaches Logistic Regression Linear DiscriminantAnalysis Quadratic DiscriminantAnalysis Regression and Classification Trees Support Vector Machines

6. Supervised Learning with Regression and Classification techniques -2 Ensemble Methods: Random Forest Neural Networks Deep learning

7. Unsupervised Learning and Challenges for Big Data Analytics Clustering Associative Rule Mining Challenges for big data anlalytics

8. Prescriptive analytics Creating data for analytics through designed experiments Creating data for analytics through Active learning Creating data for analytics through Reinforcement learning

Optional Elective Course 3.

Option 1. Cyber Law, IPR & Ethics: Syllabus same as PEC – 6 (OPTION 2)

Option 2. Neural Networks and Deep Learning: Syllabus same as PEC – 1 (OPTION 1)

Optional Elective Course 4.

Option 1. Digital Forensics: Syllabus same as PEC – 5 (OPTION 2)

Option 2. Quantum Computing: Syllabus same as PEC – 4 (OPTION 2)

CST & CSIT

COURSE OUTCOMES AND TEXT BOOKS

YEAR	SEM	COURSE	COURSE OUTCOME	TEXT BOOK
1	1	Programming for Problem Solving Using Python (ESC184)	1. To gather the basic concepts of the problem-solving approach. 2. Learn about the core syntax and semantics of the Python programming language. 3. Discover the need for working with the strings and functions. 4. To gain the knowledge of structuring the data using lists, dictionaries, tuples and sets. 5. To learn about regular expressions and different built-in functions to navigate the file systems. 6. To discover the knowledge of real-life projects on the programming language.	1. Core Python Programming by Nageswara Rao- DreamTech Press 2. Python Programming: Using Problem Solving Approach by Reema Thareja-Oxford Publishers.

1	2	Programming for Problem Solving (ESC103)	1. To learn about the basics of abstract data types. 2. To gather the knowledge of principles of linear and nonlinear data structures. 3. To learn different sorting and searching techniques. 4. To learn about the basics of python programming and its applications. 5. To impart knowledge about the representation and use of lists, tuples, and dictionaries in Python programs. 6. To learn about Python object types.	1.Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India 2.Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill 3.E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill

CST & CSIT
COURSE OUTCOMES AND TEXT BOOKS

YEAR	SEM	COURSE	CODE	COURSE OUTCOME	TEXT BOOK
2	3	Analog Electronic Circuits	ESC301	1. Illustrate the working principle of different electronic circuits and their application in real life. 2. Define semiconductor devices and different operating conditions and their performance parameters. 3. Choose proper semiconductor devices depending upon application considering economic and technology up-gradation. 4. Employ mathematical and graphical analysis considering different practical issues modeling of semiconductor devices; analyze the performance parameter of the system. 5. Recognize different signal processing circuits and the use in industrial, real life, modern control system application. 6. Use modeling/simulation parameters with standard equivalent circuit models to predict correctly the expected performance of various general-purpose electronic circuits.	1.Microelectronic Circuits, Sedra & Smith, Oxford University Press. 2.Integrated Electronics, Milman & Halkias, McGraw Hill Company. 3.Electronic devices & Circuits, Balbir Kumar & Shail B. Jain, PHI. 4.Op-amps and Linear IC's, R.A. Gayakwad, PHI.

2	3	Analog Electronic Circuits Laboratory	ESC391	1. Learn about relevant information to supplement the Analog Electronic Circuit. 2. Framework of testing strategies and select proper instruments to evaluate performance characteristics of electronic circuits. 3. To gain the knowledge of testing and experimental procedures on different types of electronic circuits and analyze their operation under different operating conditions. 4. Analyze the possible causes of discrepancy in practical experimental observations in comparison to theory. 5. To gain the knowledge of different types of wiring and instruments connections keeping in mind technical, Economical, safety issues. 6. To develop an understanding of professional quality textual and graphical presentations of laboratory data and Computational results, incorporating accepted data analysis and synthesis methods, Mathematical software and word-processing tools.	1. Millman's Integrated Electronics - Analog and Digital Circuit and Systems by Jacob Milman, Christos Halkios, Chetan Parikh, McGrawHill education. 2. Analog Electronics by J B Gupta, S K Kataria & sons publication.

2	3	Data Structure & Algorithms	PCC-CS301	1.To learn about basic concepts of structures, pointers, algorithms, analysis of algorithms and be able to identify appropriate data structures for a given problem. 2.To learn, exemplify, analyze and implement all types of linear data structures using C and Python. 3.To learn, exemplify, analyze and implement all types of non-linear data structures using C and Python. 4.To learn, compare, analyze and implement algorithms related to searching, sorting, and hashing.	1. "Data Structures and Program Design In C", 2/E by Robert L. Kruse, Bruce P. Leung. 2. "Fundamentals of Data Structures of C" by Ellis Horowitz, Sartaj Sahni, Susan Anderson-freed. 3. "Data Structures in C" by Aaron M. Tenenbaum. 4. "Data Structures" by S. Lipschutz.
2	3	Data Structure & Algorithms Laboratory	PCC-CS391	1. To learn all types of linear, non-linear data structures and their implementation using C and Python. 2. To learn to calculate time complexity and space complexity of any given algorithm. 3.To be able to learn to apply data structure knowledge in the different subjects like Design and Analysis of Algorithms, Operating Systems, Database Management Systems, Artificial Intelligence & Machine Learning in upcoming semesters.	3. "Data Structures in C" by Aaron M. Tenenbaum. 4. "Data Structures" by S. Lipschutz.

2	3	Digital Electronics	ESC302	1. Convert different type of codes and number systems which are used in digital communication and computer systems. 2. To develop an understanding of Digital electronic circuit components and their working principles. 3. To develop an understanding of different digital logic families and their applications. 4. Assess the nomenclature and technology in the area of memory devices and apply the memory devices in different types of digital circuits for real world application.	1. Digital Logic Design by Morris Mano - PHI 2. Digital Electronics by S. Salivahanan,S. Arivazhagan-OXFORD. 3.Fundamental of Digital Circuits, A. Anand Kumar, PHI. 4.Modern Digital Electronics, 2nd Edition, R.P. Jain. Tata Mc Graw Hill Company Limited.
2	3	Digital Electronics Laboratory	ESC392	1. To develop an understanding of Digital electronic circuit components and their working principles. 2. To develop an understanding of different digital logic gates and their applications. 3. Analyze different types of digital electronic circuit using various mapping and logical tools and know the techniques to prepare the most simplified circuit using various mapping and mathematical methods.	1. Digital Logic Design by Morris Mano – PHI 2. Digital Electronics by S. Salivahanan,S. Arivazhagan-OXFORD 3. Digital Electronics by P.Raja - Scitech Publications 4. Digital Fundamentals by Floyed & Jain - Pearson.

2	3	IT Workshop (Scilab/ MATLAB/ Python/R)	PCC-CS302	1. Logic Building. 2. To master an understanding of problems and finding solutions. 3. Design real life problems and think creatively about solutions 4. Apply a solution in a program using R/Matlab/Python. 5. To be exposed to advanced applications of mathematics, engineering and natural sciences to program real life problems.	1.MATLAB Programming for Engineers, 6E-Author(s): Stephen J. Chapman, ISBN: 9789353502874, Cengage Learning India Private Limited, Noida 2. The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything, CreateSpace Independent Publishing Platform; 1st edition ISBN 10: 1539894444. 3. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016. 4. Dieter Schmalstieg and Tobias Höllerer, Augmented Reality: Principles & Practice, Pearson Education India, 2016. 5. A Text Book of IT Workshop on Python Programming (NSEC, WB). Author: Das/Patra. 6. Fundamentals of Python: First Programs with MindTap. Author: Lambert.

2	3	IT Workshop Practical (Sci Lab/MATLAB/Python/R)	PCC-CS392	1. Logic Building. 2. To master an understanding of problems and finding solutions. 3. Design real life problems and think creatively about solutions 4. Apply a solution in a program using R/Matlab/Python. 5. To be exposed to advanced applications of mathematics, engineering and natural sciences to program real life problems.	1. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016. 2. Dieter Schmalstieg and Tobias Höllerer, Augmented Reality: Principles & Practice, Pearson Education India, 2016. 3. Mastering MATLAB 7,-Author(s): Duane C. Hanselman, Bruce Littlefield, ISBN: 9788131707432, Pearson Education India Pvt. Ltd. 4. Headfirst Android Development
2	3	Mathematics-III (Probability, Statistics)	BSC301	1. Use discrete and continuous probability distributions , mean and variance, and making decisions 2. Learn bivariate distributions and properties 3.Calculate and interpret the correlation between two variables, calculate the simple linear regression equation for a set of data, know the association between the attributes. 4. Know the construction of point and interval estimators and the process of estimating a parameter. 5. State appropriate null and alternative hypotheses, state the relationship between a CI for m and a test about m (one or two sided) also about s.d.	1 .Introduction to Statistics-Sheldon Ross 2. Introduction to Probability and Statistics-Mendenhall and Beaver

				6. Perform a hypothesis test and state conclusion with a sentence.	
2	3	Humanities – I (Technical Report Writing using Latex)	HSMC301	1. To expose the students in the fields of emerging technologies. 2. The students will develop a basic understanding of how to make a documentary or how to work with the designing techniques. 3. It will emphasize the learners and researchers to create a professional quality, typeset publication for their postgraduate project reports, writing scientific and technical papers. 4. By the end of the course, the participants will be confident enough to typeset their documents using LATEX.	1. Technical Communication Principles and Practice by Meenakshi Raman and Sangeeta Sharma. OUP. 2. English Grammar in Use; A self-study reference and Practice book or intermediate learners of English by Raymond Murphy; Cambridge Publications
2	3	Universal Human Values – III	HSMC302	1. The Course will give a holistic approach towards learning engineering. 2. It will encourage multi-disciplinary thoughts among budding engineers and make them more responsible citizens. 3. Students will get sensitized towards larger socio-economic, human, environmental and geographical concerns.	1. A Textbook on Human Values and Ethics by Debabrata Basu, Samarpan Chakraborty October 2020, New Delhi Publishers
2	3	Mandatory Additional Requirements (MAR)	MC381		
2	3	Innovative Project - I	PROJ-CS301		
2	3	Massive Open Online Course (Mandatory for B.Tech. (Honours))	MOOC 3		

2	4	Discrete Mathematics	PCC-CS401	1. Use logical notation & Perform logical proofs 2. Apply recursive functions and solve recurrence relations 3. Determine equivalent logic expressions 4. apply deterministic and nondeterministic automata models 5. Apply basic and advanced principles of counting 6. Define sets and sequences	1. Kenneth H. Rosen, Discrete Mathematics and Its Applications, McGraw Hill. 2. Russell Merris, Combinatorics, WILEY-INTERSCIENCE SERIES IN DISCRETE MATHEMATICS AND OPTIMIZATION 3. N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI 4. Gary Haggard, John Schlipf and Sue Whitesides, Discrete Mathematics for Computer Science, CENGAGE Learning.

2	4	Computer Organization & Architecture	PCC-CS402	1. To understand the role of operating systems and compiler/assembler. Fetch, decode and execute cycle, Concept of operator, operand, registers and storage, Instruction format. 2. To understand the concept of ALU design. 3.To understand memory Memory organization:static and dynamic memory, virtual memory, cpu memory interfacing. 4. To develop the ability to design parallel processors and the communication among processing elements.	1. Computer Organization and Architecture: Designing for Performance, William Stallings, Prentice-Hall India 2. Computer Organization, Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Tata McGraw Hill 3. Computer Architecture A Quantitative Approach, John L Hennessy and David Patterson, Morgan Kaufman 4. Structured Computer Organization, Andrew S. Tanenbaum, Prentice-Hall India
2	4	Computer Organization & Architecture Laboratory	PCC-CS492	1. To develop the ability to design the mechanism by which the performance of a system can be enhanced. 2. To understand memory storage & connections. 3. To understand communication among processing elements inside the computer architecture. 4. To understand how to simulate electronic circuits and measure their functionalities.	1. Computer Organization and Architecture: Designing for Performance, William Stallings, Prentice-Hall India 2. Computer Organization, Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Tata McGraw Hill 3. Computer Architecture A Quantitative Approach, John L Hennessy and David Patterson, Morgan Kaufman

2	4	Operating Systems	PCC-CS403	1. To gain knowledge about process management. 2. To gain knowledge about how the memory is managed by Operating Systems(OS). 3. To gain knowledge about how the operating system manages disk, files and I/O devices 4. To gain knowledge about role of OS in protection and security management	1. Milenkovie M., "Operating System : Concept & Design", McGraw Hill. 2. Tanenbaum A.S., "Operating System Design & Implementation", Practice Hall NJ. 3. Silbersehatz A. and Peterson J. L., "Operating System Concepts", Wiley. 4. Dhamdhere: Operating System TMH 5. Stalling, William, "Operating Systems", Maxwell McMillan International Editions, 1992.
2	4	Operating Systems Laboratory	PCC-CS493	1. To develop conceptual understanding of Unix commands and various filters 2. To implement various operating system concepts through programming (such as, Process, Scheduling etc.). 3. To develop understanding about shell Programming and AWK scripting 4. To develop skill to solve various unix system administration problems with the application of shell programming.	1.UNIX : Concepts and Applications | 4th Edition by Sumitabha Das, Tata McGrawHill Publishers.

2	4	Design & Analysis of Algorithms	PCC-CS404	1. Reinforce basic design concepts (e.g., pseudocode, specifications, top-down design) 2. Knowledge of algorithm design strategies 3. Familiarity with an assortment of important algorithms 4. Ability to analyze time and space complexity	1. Introduction to Algorithms, 4th Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill. 2. Algorithms, 4th Edition, Robert Sedgewick and Kevin Wayne, Princeton University. 3. Fundamental of Algorithms – E. Horowitz et al.
2	4	Design & Analysis of Algorithms Laboratory	PCC-CS494	1.To apply knowledge of computing and mathematics to algorithm design 2.To analyze a problem and identify the computing requirements appropriate for its solution 3.To design, implement, and evaluate an algorithm to meet desired needs 4.To apply mathematical foundations, algorithmic principles, and computer science theory to the modeling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices.	1. Introduction to Algorithms, 4th Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill. 2. Algorithms In A Nutshell, George T. Heineman, Gary Pollice and Stanley Selkow, O'Reilly. 3. Fundamental of Algorithms – E. Horowitz et al. 4. Algorithm Design, 1st Edition, Jon Kleinberg and EvaTardos, Pearson.

2	4	Artificial Intelligence & Machine Learning	PCC-CS405	1. To comprehend the basics of artificial intelligence and knowledge representation. 2.To develop concepts regarding search techniques. 3.To develop concepts related to machine learning and its categories. 4.To develop skills to solve problems associated with supervised and unsupervised learning	1. "Pattern Recognition & Machine Learning" Bishop. Springer 2. "The Elements of Statistical Learning" Hastie. Springer 3. "Pattern Recognition" Duda, Hart, Stork. Wiley 4. “Artificial Intelligence: A Modern Approach”, Stuart Russell and Peter Norvig. PHI 5. “Artificial Intelligence” Kevin Knight, Elaine Rich, B. Nair. THM 6. "Pattern Recognition: An Introduction", M Narasimha Murty, V Susheela Devi. Universities Press 7. “Artificial Intelligence and Machine Learning” Vinod Chandra & Hareendran, PHI 8. “Machine Learning” Tom Mitchell, THM 9. "An Introduction to Machine Learning" Kubat, Springer 10. "Machine Learning: A Practical Approach on the Statistical Learning Theory" Ponti; Mello, Springer 11. "Machine Learning with Python for Everyone" Fenner, Pearson

2	4	Artificial Intelligence & Machine Learning Laboratory	PCC-CS495	1.To comprehend the basics of artificial intelligence and knowledge representation. 2.To develop concepts regarding search techniques. 3. To develop concepts related to machine learning and its categories. 4. To develop skill to solve problems associated with supervised and unsupervised learning	1. "Hands on Machine Learning with Scikit-Learn, Keras, and Tensorflow" Geron. O'Reilly 2. "Python for Data Analysis" McKinney. O'Reilly 3. "Python Data Analytics" Nelli. Apress 4. "Data Science from Scratch" Grus. O'Reilly 5. "Machine Learning with Python Cookbook" Albon. O'Reilly 6. "AI and Machine Learning for Coders:A Programmer's Guide to Artificial Intelligence" Laurence Moroney, O'Reilly 7. "Learning TensorFlow: From Linear Regression to Reinforcement Learning" Hope, O'Reilly 8. "TensorFlow for Deep Learning: From Linear Regression to Reinforcement Learning" Ramsundar, O'Reilly
2	4	Management - I (Finance & Accounting)	HSMC401	1. The students will be able to understand the concepts related to business 2. The students will be able to apply the financial statement analysis associated with financial Data in the organization 3. The students will be able to analyze the complexities associated with the management of cost of product and services in the organization 4. The students will be able to understand the concepts of accounting of managerial decisions and	1. Financial Management by I M Pandey, Vikas Publishers.

				financial statements. 5. The students will be able to analyze the complexities associated with the management of cost of funds /capital in the organization 6. The students will be able to apply the concepts of capital budgeting decisions and corporate capital structures.	
2	4	Universal Human Values – IV	HSMC402	1. The Course will give a holistic approach towards learning engineering. 2.It will encourage multi-disciplinary thoughts among budding engineers and make them more responsible citizens. 3. Students will sensitize their students towards larger socio-economic, human, environmental and geographical concerns.	1. A Textbook on Human Values and Ethics by Debabrata Basu, Samarpan Chakraborty October 2020, New Delhi Publishers
2	4	Environmental Sciences	MC401	Students will 1. Understand core concepts and methods from ecological and physical sciences and their application in environmental problem- solving. 2. Appreciate key concepts from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions. 3. Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.	1. M.P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House (AICTE Recommended Textbook – 2018) 2. Masters, G. M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt. Ltd.,1991. 3. De, A. K., "Environmental Chemistry", New Age International

				4. Appreciate that one can apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.	
2	4	Mandatory Additional Requirements (MAR)	MC481		
2	4	Innovative Project - II	PROJ-CS401		
2	4	Massive Open Online Courses (Mandatory forB.Tech(Honours))	MOOC 4		

CST & CSIT
COURSE OUTCOMES AND TEXT BOOKS

YEAR	SEM	COURSE	CODE	COURSE OUTCOME	TEXT BOOK
3	5	Signals & Systems	ESC501	1. To understand the concepts and to analyses various signals, classification of signals, basic operations on signal, various types of system, properties of the system. 2. To understand the concept of LSI System, various responses, concept of convolution and various properties, stability and causality condition evaluation. 3. To analyses various transforms including Fourier series and Fourier transform, Laplace Transform , Z Transform. 4. To integrate the concept of Sampling Theorem and its	1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall, 1983 2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998. 3. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980

				implications- Spectra of sampled signals. Reconstruction, Aliasing and its effects. Relation between continuous and discrete time systems.	
3	5	Database Management Systems	PCC-CS501	1. The students will understand the different issues involved in the design and implementation of a database system. 2.The students will study the physical and logical database designs, database modeling, relational, hierarchical, and network models 3.The students will understand and use data manipulation language to query, update, and manage a database 4. The students will understand essential DBMS concepts such as: database security, integrity, concurrency, 5. The students will design and build a simple database system and demonstrate competence with the fundamental tasks involved with modelling, designing, and implementing a DBMS.	1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill. 2.Elmasri Ramez and Novathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing. Company. 3.Ramakrishnan: Database Management System , McGraw-Hill
3	5	Database Management Systems Laboratory	PCC-CS591	1. The students will explain basic database concepts, applications, data models, schemas & instances. 2. The students will demonstrate the use of constraints and relational algebra operations. 3. The students will describe the basics of SQL and construct queries using SQL. 4. The students will emphasize the importance of normalization in databases. 5. The students will facilitate students in Database design	1. SQL, PL/SQL the Programming Language of Oracle by Ivan Bayross-BPB publications.

				6. They will familiarize issues of concurrency control and transaction management.	
3	5	Formal Language & Automata Theory	PCC-CS502	After studying Finite Automata 1. The student will be able to define a system and recognize the behavior of a system. They will be able to minimize a system and compare different systems. 2. After studying regular language and grammar, students will convert Finite Automata to regular expressions. 3. Students will be able to check equivalence between regular linear grammar and FA. 4. After studying CFG and PDA Students will be able to minimize context free grammar. 5. Students will be able to check equivalence of CFL and PDA. They will be able to design a Turing Machine. 6. After studying Turing machine Students will be able to design Turing machine.	1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, Pearson Education Asia. 2. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Pearson Education Asia. 3. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.

3	5	Object Oriented Programming	PCC-CS503	1. The students will be able to familiarize themselves with the object oriented programming concepts. 2. The students will be able to understand object oriented programming concepts, and apply them in solving problems. 3. The students will able to introduce the principles of inheritance and polymorphism; and demonstrate how they relate to the design of abstract classes 4. The students will able to introduce the implementation of packages and interfaces 5. The students will be able to introduce the concepts of exception handling and multithreading. 6. The students will able to introduce the design of Graphical User Interface using applets and swing controls.	1. Head First Object-Oriented Analysis and Design by by Brett D. McLaughlin, Gary Pollice , Dave West, O Relly publication. 2. An Introduction to Object Oriented Programming" 3rd edition by Timothy Budd, Pearson publication.

3	5	Object Oriented Programming Laboratory	PCC-CS593	1. The students will able to understand object oriented programming concepts, and apply them in solving problems. 2. The students will able to understand the additional features of Java compared to C++. 3. The students will able to identify the difference between Compiler and Interpreter. 4. The students will able to identify the difference between applet and application. 5. The students will able to apply Object Oriented Principles of Encapsulations, Data abstraction, Inheritance, Polymorphism, Program using Exception Handling, Files and Threads, Program Using applets and swings.	1. C++: The Complete Reference, 4th Edition, by Herbert Schildt, McGrawHill publications.

3	5	Software Engineering	PCC-CS504	1. The students will able to demonstrates agility in solving software and system challenges with a comprehensive set of skills appropriate to the needs of the dynamic global computing-based society. 2. The students will be capable of diverse team and organizational leadership in computing project settings. 3. The students will able to demonstrate ethical principles in the application of computing-based solutions to societal and organizational problems. 4. Continually the students will able to acquires skills and knowledge to support a professional pathway, including (but not limited to) communication, analytic, and technical skills.	1. Software Engineering : A practitioner's approach– Pressman(TMH) 2. Software Engineering- Pankaj Jalote (Wiley-India) 3. Software Engineering- Rajib Mall (PHI) 4. Software Engineering –Agarwal and Agarwal (PHI)

3	5	Software Engineering Laboratory	PCC-CS594	1. The students will be able to demonstrate agility in solving software and system challenges with a comprehensive set of skills appropriate to the needs of the dynamic global computing-based society. 2. The students will be capable of diverse team and organizational leadership in computing project settings. 3. The students will be able to demonstrate ethical principles in the application of computing-based solutions to societal and organizational problems. 4. Continually the students will able to acquires skills and knowledge to support a professional pathway, including (but not limited to) communication, analytic, and technical skills.	1. Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India. 2. Pankaj Jalote, An integrated approach to Software Engineering, Springer/Narosa. 3. Roger S. Pressman, Software Engineering: A practitioner's approach, McGraw Hill. 4. Ian Sommerville, Software Engineering, Addison-Wesley.
3	5	Humanities II (Principles of Management)	HSMC501	Students undergoing this course are expected to: 1. To understand the roles and functions of managers at various (entry, middle and the top) levels 2. To explain the relationships between organizational mission, goals, and objectives 3. To comprehend the significance and necessity of managing stakeholders 4. To conceptualize how internal and external environment shape organizations and their responses 5. To demonstrate empirical understanding of various organizational processes and behaviours and the theories associated with them 6.To demonstrate critical thinking skills in	1. Principles of Management by J K Mitra, Oxford Publication.

				identifying ethical, global, and diversity issues in planning, organizing, controlling and leading functions of management 7. To understand organizational design and structural issues	
3	5	Professional Elective-I ((CYBER SECURITY) & (NEURAL NETWORK & DEEP LEARNING))	PEC-CS501	**CYBER SECURITY: -** 1. The students will be able to analyze and evaluate the cyber security needs of an organization. 2. The students will be able to determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation. 3. The students will be able to measure the performance and troubleshoot cyber security systems. 4. The students will be able to implement cyber security solutions and use of cyber security, information assurance and cyber/computer forensics software/tools. 5. The students will be able to comprehend and execute risk management processes, risk treatment methods, and key risk and performance indicators. **NEURAL NETWORK & DEEP LEARNING: -** Students will 1. Learn Model Neuron and Neural Network, and to analyze ANN learning, and its applications. 2. Perform Pattern Recognition, Linear classification. 3. Develop different single layer/multiple layer Perceptron learning algorithms	1. "Fundamentals of Neural Networks: Architectures, Algorithms and Applications" Fausett. Pearson 2. "Neural Networks and Learning Machines" Haykin, Pearson 3. "Neural Networks and Deep Learning: A Textbook" Charu C. Aggarwal. Springer 4. "Introduction to Deep Learning" Sandro Skansi. Springer 5. "Deep Learning from Scratch: Building with Python from First Principles" Weidman. O'reilly 6. "Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play" Foster. O'reilly

				4. Design of another class of layered networks using deep learning principles.	
3	5	Universal Human Values – V	HSMC502 (ESP)	1. The student will be able to polish and enhance various aptitude skills and cognitive knowledge. 2. The student will be able to prepare them to be successful in the fields of different competitive examinations like GATE,CAT, MAT,GMAT,UPSC, WBCS, Banking services, Indian Defence Services ,Combined Graduate Level etc. 3. The student will be able to train themselves not only for private sectors but also for public sectors to secure a fulfilling career.	1. General Studies-2022 for UPSC, SSC, PSUs by B. Singh, A.P Singh, Made Easy Publication.
3	5	Universal Human Values – V	HSMC582 (SDP)	1. The student will be able to polish and enhance various aptitude skills and cognitive knowledge. 2. The student will be able to prepare them to be successful in the fields different competitive examinations like GATE,CAT, MAT,GMAT,UPSC, WBCS, Banking services, Indian Defence Services ,Combined Graduate Level etc. 3. The student will be able to train themselves not only for private sectors but also for public sectors to secure a fulfilling career.	1.GATE-2022: Computer Science-IT Solved Papers by Made Easy editorial board, Made Easy Publication. 2. General Studies and Engg. Aptitude Practice Book by Made Easy Team, Made Easy publication.
3	5	Mandatory Additional Requirements (MAR)	MC581		

3	5	Innovative Project - III	PROJ-CS501		
3	5	Massive Open Online Courses (Mandatory for B.Tech(Honours))	MOOC 5		
3	6	Compiler Design	PCC-CS601	1. The student will be able to introduce the major concept areas of language translation and compiler design. 2. The student will be able to develop the knowledge of application of basic data structures and automata theory in different phases of compiler design 3. The student will be able to enrich the knowledge in various phases of compiler and its use. 4. The student will be able to extend the knowledge of parser by parsing LL parser and LR parser.	1. "Compiler Design" Aho, Lam, Sethi, Ullman. Pearson 2. "Modern Compiler Implementation in C" Appel. Cambridge University Press 3. "Compiler Design" Chandak, Khurana. Universities Press 4. "Modern Compiler Design" Grune. Springer
3	6	Compiler Design Laboratory	PCC-CS691	1. The student will be able to introduce the major concept areas of language translation and compiler design. 2. The student will be able to develop the knowledge of application of basic data structures and automata theory in different phases of compiler design 3. The student will be able to enrich the knowledge in various phases of compiler and its use. 4. The student will be able to extend the knowledge of parser by parsing LL parser and LR parser.	1. "lex and Yacc" John R Levine. O Reilly

3	6	Computer Networks	PCC-CS602	1. The student will be able to develop an understanding of computer networking basics. 2. The student will be able to develop an understanding of different components of computer networks,various protocols, modern technologies and their applications.	1. B. A. Forouzan – "Data Communications and Networking (3rd Ed.) " – TMH 2. A. S. Tanenbaum – "Computer Networks (4th Ed.)" – Pearson Education/PHI 3. W. Stallings – "Data and Computer Communications (5th Ed.)" – PHI/ Pearson Education 4. Zheng & Akhtar, Network for Computer Scientists & Engineers, OUP
3	6	Computer Networks Laboratory	PCC-CS692	1. The student will be able to understand the structure and organization of computer networks; including the division into network layers, role of each layer, and relationships between the layers. 2. The student will be able to understand the basic concepts of application layer protocol design; including client/server models, peer to peer models, and network naming. 3. In depth understanding of transport layer concepts and protocol design; including connection oriented and connection-less models, techniques to provide reliable data delivery and algorithms for congestion control and flow control.	1. Python Network Programming: Conquer all your networking challenges with the powerful Python language by Abhishek Ratan, Eric Chou, Pradiban Kathirelavenu and Dr. M O Faruque Sarkar, Packt publishing limited.
3	6	Cloud Computing & IOT	PCC-CS603	The student will be in position: 1. To understand the necessary theoretical background for computing and storage clouds environments. 2. To know the methodologies and technologies for the development of applications that will be deployed and offered through cloud computing environments. 3. To be able to realize cloud	1. Cloud Computing: Concepts, Technology & Architecture, 1e by Erl, Pearson Education publications.

				infrastructures by using IaaS software, while also developing cloud applications by utilizing PaaS software.	
3	6	Cloud Computing & IOT Laboratory	PCC-CS693	The student will be in position: 1. To understand the necessary theoretical background for computing and storage clouds environments. 2. To know the methodologies and technologies for the development of applications that will be deployed and offered through cloud computing environments. 3. To be able to realize cloud infrastructures by using IaaS software, while also developing cloud applications by utilizing PaaS software.	1. Cloud Computing, A Practical Approach by Toby Velte, Anthony Velte, Robert Elsenpeter, McGrawHill publication.
3	6	Professional Elective-II ((SOFT COMP0UTING) & (HUMAN COMPUTER INTERACTION))	PEC-CS601	**SOFT COMPUTING:-** 1. The student will be able to comprehend the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory. 2. The student will be able to understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic 3. The student will be able to understand the fundamental theory and concepts of neural networks, Identify different neural network architectures, algorithms, applications and their limitations 4. The student will be able to understand appropriate learning rules for each of the architectures and learn several neural network paradigms and its applications 5. The student will be able to	1. "Fundamentals of Neural Networks: Architectures, Algorithms and Applications" Fausett. Pearson 2. "Neural Networks and Learning Machines" Haykin, Pearson 3. "Fuzzy Sets and Fuzzy Logic: Theory and Applications" George J. Klir / Bo Yuan, Pearson 4. "Fuzzy Logic with Engineering Applications" Ross. Wiley 5. "Genetic Algorithms In Search, Optimization And Machine Learning" Goldberg. Pearson 6. "Optimization for Engineering Design: Algorithms and Examples" K. Deb. PHI 7. "Principles of Soft Computing" S.N. Sivanandam, S.N. Deepa. Wiley

				reveal different applications of these models to solve engineering and other problems. **HUMAN COMPUTER INTERACTION: -** Students will 1. Understand the theoretical dimensions of human factors involved in the acceptance of computer interfaces. 2. Understand the important aspects of implementation of human-computer interfaces. 3. Identify the various tools and techniques for interface analysis, design, and evaluation. 4. Identify the impact of usable interfaces in the acceptance and performance utilization of information systems. 5. Identify the importance of working in teams and the role of each member within an interface development phase.	8. "Soft Computing and Intelligent Systems" Karray. Pearson
3	6	Professional Elective-III (DATA ANALYTICS) & (BLOCKCHAIN)	PEC-CS602	**DATA ANALYTICS** 1. The student will be able to identify the characteristics of datasets and compare the trivial data and big data for various applications. 2. The student will be able to select and implement machine learning techniques and computing environment that are suitable for the applications under consideration. 3. The student will be able to solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues. 4. The student will be able to understand and apply scaling up	1. "Data Mining" Han, Kamber. Morgan Kaufmann 2. "Data Mining" Tan, Steinbach. Pearson 3. "Principles of Data Mining" Bramer. Springer 4. "Probability and Statistics for Computer Science" Forsyth. Springer 5. "An Introduction to Statistical Learning: with Applications in R" Hastie, Tibshirani. Springer 6. "Data Mining" Witten, Frank, Hall, Pal. Morgan Kaufmann

				machine learning techniques and associated computing techniques and technologies. 5. The student will be able to recognize and implement various ways of selecting suitable model parameters for different machine learning techniques. **BLOCKCHAIN** 1. Students will be able to explain design principles of Bitcoin and Ethereum. 2. Students will be able to explain Nakamoto consensus. 3. Students will be able to explain the Simplified Payment Verification protocol. 4. Students will be able to list and describe differences between proof-of-work and proof- of-stake consensus. 5. Students will be able to interact with a blockchain system by sending and reading transactions. 6. Students will be able to design, build, and deploy a distributed application. Students will be able to evaluate security, privacy, and efficiency of a given blockchain system.	
3	6	Open Elective-I (HUMAN RESOURCE DEVELOPMENT &	OEC-CS601	Students undergoing this course are expected to 1. Learn about organizations, their structure, purpose and theories concerning organizations. 2. Understand employee behavioural dynamics in organizations. 3. Understand individual and group behaviours in organizational context	

		ORGANIZATIONAL BEHAVIOUR)		4. Learn about developmental aspect of human resources. 5. Learn the fundamentals of team building, organizational culture building, competency building 6. Develop concepts on Human Capital.	
3	6	Project – I	PROJCS601		
3	6	Universal Human Values – VI	HSMC602 (ESP)	1. The student will be able to polish and enhance various aptitude skills and cognitive knowledge. 2. The student will be able to prepare them to be successful in the fields of different competitive examinations like GATE,CAT, MAT,GMAT,UPSC, WBCS, Banking services, Indian Defence Services ,Combined Graduate Level etc. 3. The student will be able to train themselves not only for private sectors but also for public sectors to secure a fulfilling career.	1.GATE-2022: Computer Science-IT Solved Papers by Made Easy editorial board, Made Easy Publication. 2. General Studies and Engg. Aptitude Practice Book by Made Easy Team, Made Easy publication.
3	6	Universal Human Values – VI	HSMC682 (SDP)	1. The student will be able to polish and enhance various aptitude skills and cognitive knowledge. 2. The student will be able to prepare them to be successful in the fields of different competitive examinations like GATE,CAT, MAT,GMAT,UPSC, WBCS, Banking services, Indian Defence Services ,Combined Graduate Level etc. 3. The students will be able to train themselves not only for private	1. General Studies-2022 for UPSC, SSC, PSUs by B. Singh, A.P Singh, Made Easy Publication.

				sectors but also for public sectors for securing jobs.	
3	6	Mandatory Additional Requirements (MAR)	MC681		
3	6	Massive Open Online Courses (Mandatory for B.Tech(Honours))	MOOC 6		

CST & CSIT
COURSE OUTCOMES AND TEXT BOOKS

YEAR	SEM	COURSE	CODE	COURSE OUTCOME	TEXT BOOK
4	7	Network Security & Cryptography	PCC-CS701	After successful completion of the course the students should be able to 1. Identify the security issues in the network and resolve it. 2. Analyse the vulnerabilities in any computing system and hence be able to design a security solution. 3. Evaluate security mechanisms using rigorous approaches by key ciphers and Hash functions. 4. Demonstrate various network security applications, IPSec, Firewall, IDS, Web Security, Email Security and Malicious software etc.,	1.William Stallings: Cryptography and Network Security, seventh edition ISBN 978-1-292-15858-7 or sixth edition ISBN 978-0-273-79335-9. 2.John E. Canavan, "The Fundamentals of Network Security," Artech House, February 2001, 350 pages. 3.Simon Singh, The Code Book: The Science of Secrecy from Ancient Egypt to Quantum Cryptography
				SPEECH & NATURAL LANGUAGE PROCESSING: After successful	1.Raj Kamal, Embedded Systems Architecture, Programming, and Design.

4	7	Professional Elective - IV ((SPEECH & NATURAL LANGUAGE PROCESSING) & (EMBEDDED SYSTEM))	PEC-CS701	completion of the course the students should be able:- 1. To develop ability to pre-process natural language 2. To develop an understanding of different feature extraction techniques in NLP 3. To develop skill to solve complex problems associated with NLP **EMBEDDED SYSTEM:** 1. Students have knowledge about the basic functions, structure, concepts and applications of embedded systems. 2. To learn the method of designing and program an Embedded Systems for real time applications. 3. To understand operating system concepts and types. 4. Students have knowledge about basic communication protocols. To understand different concepts of a RTOS, sensors, memory interface, communication interface.	(2/e), Tata McGraw Hill, 2008. 2.K.V. Shibu, Introduction To Embedded Systems, Tata McGraw, 2009. 3.Peter Barry and Patric Crowley, Intel architecture for Embedded system 4.Embedded system: Architecture Programming and Design, Raj kamal, TMH Publication ISBN 13: 9780070667648
4	7	Professional Elective - V ((IMAGE PROCESSING) &	PEC-CS702	**IMAGE PROCESSING:** After successful completion of the course the students should be able:- 1. To introduce the concepts of image processing and basic analytical methods to be used in image processing. 2. To familiarize students with image enhancement and restoration techniques, to explain different image compression techniques. 3. To introduce segmentation and	1.R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison-Wesley, 1992. 2.A. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall 3.A. Rosenfeld and A. C. Kak, Digital Picture Processing, Elsevier 4.Darren R. Hayes, A Practical Guide to Digital Forensics Investigations 5.The Best Damn Cybercrime and Digital Forensics Book

		(DIGITAL FORENSICS))		morphological processing techniques. **DIGITAL FORENSICS:** Having studied this course, students are expected to be to: 1. Define computer forensics. 2. Identify the process in taking digital evidence. 3. Describe how to conduct an investigation using methods of memory, operating system, network and email forensics. 4. Assess the different forensics tools. 5. Differentiate among different types of security attacks. 6. Describe the concept of ethical hacking.	Period 1st Edition by Jack Wiles, Anthony Reyes, Jesse Varsalone 6.The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics 2nd Edition by John Sammons
4	7	Open Elective-II (CYBER SECURITY), (DATA ANALYTICS)	OEC-CS701	**DATA ANALYTICS:** 1. The student will be able to identify the characteristics of datasets and compare the trivial data and big data for various applications. 2. The student will be able to select and implement machine learning techniques and computing environment that are suitable for the applications under consideration. 3. The student will be able to solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues. 4. The student will be able to understand and apply scaling up	1.David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann/El sevier Publishers, 2013. 2.David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann/Elsevier Publishers, 2013. 3.Cyber security by Nina Gobole & Sunit Belapune; Pub: Wiley India. 4.Cyber Security by Jocelyn O. Padallan

				machine learning techniques and associated computing techniques and technologies. 5. The student will be able to recognize and implement various ways of selecting suitable model parameters for different machine learning techniques. **CYBER SECURITY:** 1. The students will be able to analyze and evaluate the cyber security needs of an organization. 2. The students will be able to determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation. 3. The students will be able to measure the performance and troubleshoot cyber security systems. 4. The students will be able to implement cyber security solutions and use of cyber security, information assurance and cyber/computer forensics software/tools. 5. The students will be able to comprehend and execute risk management processes, risk treatment methods, and key risk and performance indicators	
4	7	Project – II	PROJ-CS701		
4	7	Universal Human Values – VII	HSMC702 (ESP)	1. The student will be able to polish and enhance various aptitude skills and cognitive knowledge. 2. The student will be able to prepare them to be successful in	1.Indian Constitution by M laxmikant 2.Indian Economy by Ramesh Singh 3.India's Ancient Past by R S Sharma

				the fields different competitive examinations like GATE,CAT, MAT,GMAT,UPSC, WBCS, Banking services, Indian Defence Services ,Combined Graduate Level etc. 3. The student will be able to train themselves not only for private sectors but also for public sectors to secure a fulfilling career.	4.Geography of India by Majid Hussain 5.Current Affairs Magazine of IEM-UEM
4	7	Universal Human Values – VII	HSMC782 (SDP)	1. The student will be able to polish and enhance various aptitude skills and cognitive knowledge. 2. The student will be able to prepare them to be successful in the fields different competitive examinations like GATE,CAT, MAT,GMAT,UPSC, WBCS, Banking services, Indian Defence Services ,Combined Graduate Level etc. 3. The student will be able to train themselves not only for private sectors but also for public sectors to secure a fulfilling career.	
4	7	Mandatory Additional Requirements (MAR)	MC781		
4	7	Massive Open Online Courses (Mandatory for B.Tech(Honours))	MOOC 7		

4	8	Professional Elective -VI ((CYBER LAW, IPR &	PEC-CS801	**CYBER LAW, IPR & ETHICS:** 1. Student will be able to make Learner Conversant with the social and intellectual property issues	1.Cyber security by Nina Gobole & Sunit Belapune; Pub: Wiley India. 2.Cyber Law of Information Technology

		ETHICS) & (QUANTUM COMPUTING))		emerging from ‘cyberspace. 2. Student will be able to explore the legal and policy developments in various Countries to regulate cyberspace; 3. Student will be able to develop process to file an IPR application 4. Student will be able to implement cyber security 5. Student will be able to suggest legal action to be taken against the cyber crimes 6. Develop the understanding of relationship between commerce and cyberspace; and 7. Give learners in depth knowledge of information technology Act and legal frame work of right to privacy, data security and data protection. **QUANTUM COMPUTING:** 1. Students are able to understand the basic principles of quantum computing. 2. Students are capable to find the fundamental differences between conventional computing and quantum computing. 3. Students are get to know some basic quantum computing algorithms. 4. Students are able to learn different quantum information theory and quantum cryptography techniques. 5. Students are able to find out the classes of problems that can be expected to be solved well by quantum computers.	And Internet by Anirudh Rastogi, First Edition 3.Open Source and The Law by Priti Suri & Associates, First Edition 4.Nielsen M. A., Quantum Computation and Quantum Information,Cambridge University Press 5.Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific.
4	8	Open Elective-III ((CYBER LAW,IPR & ETHICS) & (NEURAL	OEC-CS801	**CYBER LAW, IPR & ETHICS:** 1. Student will be able to make Learner Conversant with the social and intellectual property issues emerging from ‘cyberspace.	1.Cyber Law of Information Technology And Internet by Anirudh Rastogi, First Edition 2. Open Source and The Law by Priti Suri & Associates, First Edition

		NETWORK & DEEP LEARNING))		8. Student will be able to explore the legal and policy developments in various Countries to regulate cyberspace; 9. Student will be able to develop process to file an IPR application 10. Student will be able to implement cyber security 11. Student will be able to suggest legal action to be taken against the cyber crimes 12. Develop the understanding of relationship between commerce and cyberspace; and Give learners in depth knowledge of information technology Act and legal frame work of right to privacy, data security and data protection. **NEURAL NETWORK & DEEP LEARNING: -** Students will 5. Learn Model Neuron and Neural Network, and to analyze ANN learning, and its applications. 6. Perform Pattern Recognition, Linear classification. 7. Develop different single layer/multiple layer Perceptron learning algorithms Design of another class of layered networks using deep learning principles.	3. E-Commerce- The cutting edge of business by Kamlesh K. Bajaj, TMH 4.Ian Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach, Deep Learning, the MIT Press. 5.Fundamenals of Deep Learning – by Nikhil Buduma (O'Reilly). 6. Deep Learning – A practitioner's approach – by Josh Patterson & Adam Gibson (O'Reilly)
4	8	Open Elective-IV ((DIGITAL FORENSICS) & (QUANTUM COMPUTIN G))	OEC-CS802	**DIGITAL FORENSICS:** Having studied this course, students are expected to be to: 7. Define computer forensics. 8. Identify the process in taking digital evidence. 9. Describe how to conduct an investigation using methods of memory, operating system, network and email forensics. 10. Assess the different forensics	1.Darren R. Hayes, A Practical Guide to Digital Forensics Investigations) 2.The Best Damn Cybercrime and Digital Forensics Book Period 1st Edition by Jack Wiles, Anthony Reyes, Jesse Varsalone 3.The Basics of Digital Forensics: The Primer for Getting Started in Digital

				tools. 11. Differentiate among different types of security attacks. Describe the concept of ethical hacking. **QUANTUM COMPUTING:** 6. Students are able to understand the basic principles of quantum computing. 7. Students are capable to find the fundamental differences between conventional computing and quantum computing. 8. Students are get to know some basic quantum computing algorithms. 9. Students are able to learn different quantum information theory and quantum cryptography techniques. Students are able to find out the classes of problems that can be expected to be solved well by quantum computers.	Forensics 2nd Edition by John Sammons 4.Nielsen M. A., Quantum Computation and Quantum Information,Cambridge University Press. 5. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific.
4	8	Project – III	PROJ-CS801		
4	8	Universal Human Values – VIII	HSMC802	1. The student will be able to polish and enhance various aptitude skills and cognitive knowledge. 2. The student will be able to prepare them to be successful in the fields different competitive examinations like GATE,CAT, MAT,GMAT,UPSC, WBCS, Banking services, Indian Defence Services ,Combined Graduate Level etc. 3. The student will be able to train themselves not only for private sectors but also for public sectors to secure a fulfilling career.	
				1. The student will be able to polish and enhance various	

4	8	Universal Human Values – VIII	HSMC882	aptitude skills and cognitive knowledge. 2. The student will be able to prepare them to be successful in the fields different competitive examinations like GATE,CAT, MAT,GMAT,UPSC, WBCS, Banking services, Indian Defence Services ,Combined Graduate Level etc. 3. The student will be able to train themselves not only for private sectors but also for public sectors to secure a fulfilling career.	
4	8	Grand Viva-Voce	PCC S881		
4	8	Mandatory Additional Requirements (MAR)	MC881		
4	8	Massive Open Online Courses (Mandatory for B.Tech(Honours))	MOOC8		