Academic Programme Guide
of
Master of Engineering
(Computer Science and Engineering)

Based on Choice Based Credit System (CBCS)/Elective Course System

CHITKARA UNIVERSITY

HIMACHAL PRADESH - NAAC Accredited

w.e.f.
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1. General Information

The M.E. Programme is a modular Programme consisting of 3 academic years. It consists of core courses, specialized courses and a dissertation project spanned across one entire academic year. The students seeking admission to the Programme are expected to have basic knowledge of Computer architecture, Computer network, Data base systems and software engineering. These courses constitute prerequisites for the M.E. (CSE) Programme. The courses offered in the Programme challenge the intellect of the students and enhance their knowledge. In addition to this the dissertation project let the students explore their research and development skills and to be a part of the various exciting research projects going on in the Department. This Programme offers a balanced emphasis on theoretical and practical knowledge in areas of software engineering, applications of computing, networks and more.

1.1 Programme Educational Objectives (PEO)

PEO 1.   The post-graduating students can opt professional career in technical domain or pursue higher studies.

PEO 2.   The post-graduating students can solve social problems by designing/developing the products with the help of acquired knowledge.

PEO 3.   The post-graduating students would be able to have good communication skills, leadership quality, and ethical values.

PEO 4.   The post-graduating students would be capable to use the techniques, skills, and modern engineering tools**.**

1.2 Programme Outcomes (PO)

The department expects undergraduate students to be able to demonstrate the following outcomes. The students are expected to be able to:

PO1.   Possess an ability to apply knowledge of Computer Science & Engineering.
PO2.   Possess an ability to design and conduct experiments, as well as to analyze and interpret data.
PO3.   Possess an ability to design a system, component or process to meet desired meets within realistic constraints such as economics, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
PO4.   Possess an ability to function on multidisciplinary teams.
PO5.   Possess an ability to identify, formulate and solve engineering problems
PO6.   Possess an understanding professional and ethical responsibility.
PO7.   Possess an ability to communicate effectively.
PO8.   Possess a capability to understand impact of engineering solutions in a global, economic, environmental, and societal context.
PO9.   Possess an ability to recognize the need for, and an ability to engage in life-long learning.
PO10.   Possess an ability to use the techniques, skills, and modern engineering tools necessary for engineering.

1.3 University Vision and Mission

Vision:

To be a globally recognized organization promoting academic excellence through interdisciplinary applied research and to expand realms of knowledge through innovation.

Mission:

M1. To carry out the academic processes in accordance with global standards through active teacher-student-industry participation.

M2. To promote research, innovation and entrepreneurship in collaboration with industry, research laboratories and academic institutions of global repute.

M3. To inculcate high moral, ethical and professional values amongst our students, faculty & staff.

M4. To contribute in building skillful society.

In M.E. Computer Science Engineering Programme, the programme educational objectives (PEOs) are well-designed on the mission of providing the graduating students with knowledge and expertise required for professional practices in engineering and the necessary technical skills for working in corporate industries.

To enrich student's interpersonal skills, variety of extracurricular activities have been inculcated in the course curriculum in the form of national level technical and cultural festivals such as Algorithm and Hackathons respectively on yearly basis. A vital role is played by the department for overall grooming of the student through organizing industrial visits, workshops and technical quizzes/debates and project showcase competitions. The students are offered to participate or organize such events. These value-added activities have been designed taking into account various Programme Objectives (POs) such as PO3, PO6, PO7, PO9, and PO10, and have been in accordance with all the mentioned Programme Educational Objectives (PEOs). By offering additional sports related activities, the overall purpose of service-learning is achieved with an emphasis on good health and well-being.

The programme also aims at achieving the sustainable development goals set up by the United Nations. PO3, PO7 and PO10 promote development for sustainable society, which depends on three aspects: Economic Forces, Public policy changes, Changes in Life-style. An engineer can contribute to sustainable development; as the role of technology in the transition to a sustainable society is a central one. Present day technologies include Machine learning, Digital image processing, cryptography and network security and advanced computer networks. The Programme of Computer Science Engineering is designed to build innovators, entrepreneurs, leaders and responsible citizens with the above-mentioned skills and knowledge that will help them contribute to achieving the UN 2030 agenda.

PEOs and POs are designed and oriented to meet the mission of university. The PEOs ensure that the graduating students are well equipped with technical knowledge, command over communication skills, leadership qualities, accomplishment of life-long learning to apply for solving the relevant engineering problems in community at local, national and international level, thereby helping establish a balanced social and professional environment. Thus, the objective of the programme is to produce high quality analytic and creative minded computer engineers to transform the society into knowledgeable, and sustainable society.

1.4 Programme Constitution

- The courses offered in first year are core subjects and elective subjects.
- In the second year there are 2 core subjects and 3 elective subjects. Also, 'Intellectual Property Rights (IPR)' will be taught in 1st and 2nd to avail the knowledge of writing research paper and patent filing at the initial stage of their ME programme.

- Subject "Research Methodology" is introduced in the 3rd semester so that students can learn analysis tools in the initial stage of research work.
- The course "Preliminary Thesis work and Thesis work will be done by the students in the year 3 along with the Research paper communicated/accepted/published in Scopus indexed conference/journal. This research paper will be based on the research objectives.
- We follow outcome-based education and programme outcomes are mapped with course outcomes. For details see the appendix A of mapping report.

1.5 Placement Opportunities

The course of M.E. in Computer Science offers wide job prospects in I.T and software firms. There are various private as well as government sector jobs available for post graduates in CSE.

2. <u>Eligibility for Admission</u>

The students seeking admission in M.E. CSE Programme should have minimum 60% marks or minimum 6.0 CGPA on the scale of 10 in their B.E. / B.Tech. [Electronics/Electrical/CSE/IT] or MSc [CS]/MSc [IT] or MCA. The admission is based on criteria set by the university statutory body.

3. <u>Programme Duration</u>

The duration of the M.E. Programme is three years - divided into 6 semesters. Maximum duration of the Programme is N+2 years where "N" stands for minimum or normal duration prescribed for completion of the Programme. Thus, the maximum duration for completion of M.E. Programme is 5 years. In exceptional circumstances, further extensions of one year may be granted on the recommendation of concerned statutory body of the university.

4. <u>Pedagogical Aspects</u>

The structural layout of the Programme and its courses requires that each course be divided in lecture, tutorial and practical sessions. Duration of each session as given in the column against the course in the course scheme is one hour.

Lecture sessions: Lectures are delivered by traditional - chalk board method, supplemented by modern Information Communication technology (ICT) methods. The students are encouraged to ask questions and involve in group discussion to the extent allowed by the teacher. In some subjects where case-study based methodology is adopted, the lectures are supplemented by discussions on case studies.

5. <u>Programme Structure</u>

	Semester-1			
S.No	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1	CS902	Data Warehouse & Mining	4-0-0	4
2	CS924	Digital Image Processing	3-0-0	3
3	CS925	Digital Image Processing Lab	0-0-2	1
4	CS921	Advanced Computer Networks	3-0-0	3
5	CS922	Advanced Computer Networks Lab	0-0-2	1
6	RS991	Intellectual Property Rights and	1-0-0	1

		Publishing Research (I)		
			15	**13**

Semester-2				
S.No	Course Code	Course Title	L-T-P	Credits
1	RS992	Intellectual Property Rights and Publishing Research (II)	1-0-0	1
2	CS908	Advanced DBMS	4-0-0	4
3	CS909	Advanced DBMS Lab	0-0-2	1
4	CS913	Advanced Operating Systems	3-0-0	3
5	CS903	Cryptography & Network Security	4-0-0	4
			14	**13**

Semester-3				
S.No	Course Code	Course Title	L-T-P	Credits
1	RS993	Research Methodology	3-0-0	3
2	CS906	Advanced Data Structures	3-0-0	3
3	CS907	Advanced Data Structures Lab	0-0-2	1
4		Elective - I	4-0-0	4
			12	**11**

Semester-4				
S.No	Course Code	Course Title	L-T-P	Credits
1	CS910	Distributed Computing	3-0-0	3
2	CS911	Distributed Computing Lab	0-0-2	1
3	-	Elective - II	4-0-0	4
4	-	Elective - III	4-0-0	4
			13	**12**

Semester-5				
S.No	Course Code	Course Title	L-T-P	Credits
1	RS993	Preliminary Thesis Work	0-0-16	8
			16	**8**

Semester-6				
S.No	Course Code	Course Title	L-T-P	Credits
1	RS995	Thesis	0-0-30	15
			30	**15**

Total Credits = 72

Programme Electives				
Elective I				
S.No	Course Code	Course Title	L-T-P	Credits
1	CS951	Programming in C#	4-0-0	4
2	CS952	Programming in Python	4-0-0	4

S.No	Course Code	Course Title	L-T-P	Credits
Elective II				
S.No	Course Code	Course Title	L-T-P	Credits
1	CS 954	Advanced Programming in Java	4-0-0	4
2	CS 955	Virtual Private Network	4-0-0	4
3	CS 956	Bioinformatics	4-0-0	4
4	CS 957	Software testing & Quality Assurance	4-0-0	4
5	CS 958	S/W Project Management	4-0-0	4
6	CS 959	Cloud Computing & Virtualization	4-0-0	4
7	CS 960	Natural Language Processing	4-0-0	4
8	CS 961	Pattern Recognition	4-0-0	4
9	CS 962	Next Generation Wireless & Sensor Networks	4-0-0	4
Elective III				
S.No	Course Code	Course Title	L-T-P	Credits
1	CS 953	Programming in R	4-0-0	4
2	CS 963	Big Data Analytics	4-0-0	4
3	CS 964	Soft Computing	4-0-0	4
4	CS 965	Communication Network and Protocols	4-0-0	4

6. Assessment and Evaluation

The evaluation will be continuous and the weight-age of various components is as given in Tables specified for each type of course. The evaluation of all courses will be detailed in the course handout document prepared by the course coordinator with the approval of Dean. The document will be shared with students before the start of the session.

Evaluation for Core / Elective / Specialization Course:

Courses can be evaluated in one of these three ways depending upon the course					
Evaluation Component	Weightage (%)	Evaluation Component	Weightage (%)	Evaluation Component	Weightage (%)
Quizzes/Assignments/ Class Tests/Case Studies	10	Formative Assessments (FAs)	20	Sessional Tests (STs)	40
Sessional Tests (STs)	30	Sessional Tests (STs)	30		
End Term Examination	60	End Term Examination	50	End Term Examination	60
Total	**100**	**Total**	**100**	**Total**	**100**

Evaluation components for Theory Courses

There are three Sessional Tests (STs) for all theory papers, the average of the best two are considered. However, the course coordinator, with the approval of Dean may decide the number of STs required for a specific course. The policy on the evaluation component – 'Quizzes / Tutorials / Assignments' (if applicable else weightage is merged in STs) as decided by the course coordinator and Dean and is announced separately for each course.

The evaluation components for Lab Courses have weightage for regular lab performances, internal viva-voce, conducted at the end of the academic semester. The End Term Examination for lab courses includes the conduct of experiments and an oral examination (viva voce).

Lab Courses	
Evaluation Component	Weightage (%)
Lab Performances / File work	40
Internal Viva – Voce	20
End Term	40
Total	**100**

Evaluation Components for Lab Courses

Thesis Evaluation Components	
Evaluation Component	Weightage (%)
Synopsis	20
Mid Term	30
Viva	50
Total	100

Evaluation Component for Thesis

7. Rules for Attendance

The program being highly rigorous, all the students are expected to show utmost regularity in attendance. Even a day's absence is detrimental to a student's interest. Therefore, the University's requirements in this regard are very stringent.

The University expects its students to be regular in attending the classes. 75% attendance (of all held sessions – lectures, tutorials, project work) is compulsory in a course to be eligible to appear for End Term Examination. The students are also encouraged for participation in co-curricular activities and can do so in 25% cushion provided in the attendance requirements. 10% concession in attendance requirements is possible only in case of extreme circumstances and at the sole discretion of the Vice-Chancellor.

8. Grading System

The list of Letter Grades is given below:

% Marks Range of total	Grade	Grade Point	Qualitative Meaning
80-100	O	10	Outstanding
70-79	A+	9	Excellent
60-69	A	8	Very Good
55-59	B+	7	Good
50-54	B	6	Above Average
45-49	C	5	Average
40-44	P	4	Pass
0-39	F	0	Fail
	AB		Absent

If a student obtains grade P or above, he/she is declared pass in that course. The grade F is equivalent to failing in that course, in which case, the student has to reappear in the end term examination of that course again, whenever its exam is conducted again with the regular examination, after payment of appropriate examination fee. The rules for grading in reappear exam will be applicable as per the examination policy of the University.

If the student is detained from appearing in the end term examination because of the shortage of attendance in the regular semester or is absent at the end term exam, his/her grade in that course is I, till he/she appears again in the end term examination and obtains a new grade.

Calculation of CGPA:

The CGPA (calculated on a 10-point scale) would be used to describe the overall performance of a student (from the semester of admission till the point of reckoning) in all courses for which LETTER GRADES will be awarded. SGPA will indicate the performance of the student for any particular semester. Formulas for calculation of SGPA and CGPA have been provided as below:

$$SGPA_i = \frac{\sum_{j=1}^{n} C_{ij} G_j}{\sum_{j=1}^{n} C_{ij}}$$

$$CGPA = \frac{\sum_{i=1}^{N} \left(SGPA_i * \sum_{j=1}^{n} C_{ij}\right)}{\sum_{i=1}^{N} \left(\sum_{j=1}^{n} C_{ij}\right)}$$

Where n = number of courses in the semester; N = number of semesters; $SGPA_i$ = SGPA for the ith semester; C_{ij} = number of credits for the jth course in the ith semester; and G_j = Grade point corresponding to the grade obtained in the jth course.

Example to Understand the Calculation of SGPA:

Suppose a student is registered in four courses 'W', 'X', 'Y' and 'Z' in a particular semester as mentioned below in the Column - I of the table given below. Column - II in the table below depicts the number of credits, which those courses carried. At the end of the semester, the student was awarded the grades as mentioned in Column – III in the table given below. Column – IV indicates the corresponding grade weight. Column – V and Column – VI indicate essentially the Credit value and Grade Points for every course completed by a student in that particular semester.

Courses in which student registered (Column – I)	Credits (Column – II)	Letter Grade (Column – III)	Grade Value (Column – IV)	Credit Value (Column – V)	Grade Points (Column – VI)
Course W	3	B+	7	3 x 7	21
Course X	3	A	8	3 x 8	24
Course Y	3	A+	9	3 x 9	27
Course Z	2	O	10	2 x 10	20
Total	**11**			**Total**	**92**

Thus, the total SGPA of the student would be

$$SGPA = \frac{Total\,grade\,pts.}{Total\,no.\,of\,credits} = \frac{92}{11} = 8.36$$

Suppose the SGPA of the student in two successive semesters is 7.0 and 8.0 with respective course credits being 12 and 11, then the CGPA would be

$$CGPA = \frac{7 \times 12 + 8 \times 11}{12 + 11} = \frac{84 + 88}{23} = 7.48$$

9. Promotion and Registration

Any Bonafide student, who appears for the examination conducted by the University, shall be promoted to the next higher semester and shall carry forward all course(s) in which he/she is declared fail. The student shall have to pass all papers within the stipulated maximum duration as prescribed by the University to qualify for the award of the degree.

All students are eligible to register for next semester irrespective of the number of backlogs.
A student is not permitted to register in a term if
  (a) He / She has dues outstanding to the University, hostel, or any recognized authority or body of the University, or
  (b) His / Her grade sheet in his/her immediately preceding term is withheld, or
  (c) He / She has been specifically debarred or asked to stay away from that term

Late registration may be granted in case a student fails to register on the stipulated date. Students failing to register on the specified day of registration will be allowed to register only after permission from Head of the Department and after paying the stipulated late fee. Any student who has not registered will not be allowed to attend classes.

The registration of the student may be cancelled, if at the later stage, it is found that the student is not eligible for registration due to the following reasons:
  (a) If the registration of a student in a course is not found to be as per the regulations, his/her registration in that course will be cancelled and the grade obtained, if any, will be rejected.
  (b) The registration of a student in a course or complete set of courses in a term can be cancelled by the concerned authority when he is found guilty in case of unfair means, breach of discipline, etc. or when he/she persistently and deliberately does not pay his dues.
  (c) Absence for a period of four or more weeks at a stretch during a term shall result in automatic cancellation of the registration of a student from all the courses in that term.

A student who is duly registered in a term is considered to be on the rolls of the university. After registration, if he/she withdraws from the term, or has been given prior permission to temporarily withdraw from the University for the term, or has been asked to stay away by an appropriate authority of the University will be considered to be on the rolls of the University for that term. While such a student retains the nominal advantage of being on the rolls of the University the loss of time from studies and its consequences cannot be helped by the University.

If for any valid reason a student is unable to register in a term, he/she must seek prior permission of Head of the Department to drop the term. If such permission has not been

requested or after a request, the permission has been denied, his/her name would be struck off the rolls of the University and he would no longer be a student of the University. His/her case will be automatically processed and the file will be closed. However, if such a student, after his/her name has been struck off the rolls of the University, is permitted to come back, his/her case can be considered at the sole discretion of the competent authority of the University with the provision that all his/her previous records as a former student are revived under the current academic and administrative structure, regulations and schedule of fees.

10. Migration/Credit Transfer Policy

The following procedures will be followed for credit transfer for a student under migration, studied in other Universities in India and Abroad:

"The credits earned by the student from the other universities in India or abroad shall be transferred as such. The Degree shall only be awarded to the candidate subject to the condition that student earned the minimum no. of credit defined by Academic Regulation/APG of the Programme run by the Chitkara University."

In case a student undergoes international exchange programme or internship for 1 semester/ 1 year/ 2 years, then the courses, credits and grades earned by the student in abroad during that period should be reflected on the grade card issued by the Chitkara University. The courses will be marked as (*) on the grade card/transcript. The description of the (*) will be "credits and grades as adopted university/institute name . . . . during the international exchange programme.

In case of availability of seats, a student can apply for branch change. The student shall have to pass all papers of the first year and possess minimum CGPA criteria. Preference will be given to high CGPA.

11. Eligibility to Award the Degree

In addition to conditions given in section 8 of Academic Regulations, a CGPA of 5.5 and minimum credit of 72 is required to receive degree in any of the Master of Engineering Programs. A student is deemed to have become eligible for the degree if, in addition to satisfying the above requirements he has:

a) Satisfied all rules of evaluation.
b) No case of indiscipline or unfair means is pending against him.

However, in case of a student having outstanding dues against him to be paid to the University, Hostel or any other recognized organ of the University, his degree will be withheld until the said dues are cleared.

Under extreme exceptional circumstances where gross violation of graduation is detected at a later stage the Academic Council may recommend to the Governing Body the recall of a degree already awarded.

12. **Programme Overview**

Programme Name: Master of Engineering-Fellowship in Computer Science and Engineering
Duration: 3 years (Normal)
This postgraduate programme in Computer Science Engineering prepares students for the ever-expanding computer engineering fields. The students take in all 21 courses of which 8 are core courses and 3 are elective courses. The programme prepares students on basic and advanced subjects of computer engineering and also builds necessary engineering skills in areas of Computer architecture, Computer network, Data base systems and software engineering. The students get an overview of basic and advanced programming concepts and also learn them to apply in real life applications. Training the students with help of a 100 % application oriented and project-based learning approach remains the key strength of the programme.

Course Code	Course Name	L-T-P	Credits
CS902	Data Warehouse & Mining	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Understand the functionality of the various data mining and data warehousing components.

CLO.2: Appreciate the strengths and limitations of various data mining and data warehousing models

CLO.3: Acquire knowledge about data pre-processing, quality, manage, manipulate, clean and analyse data.

CLO.4: Model an application's data requirements using conceptual model tools skills like BI tools and strategies.

CLO.5: To implement various data clustering and classification approaches.

Course Outline:

Relational Databases: Integrity Constraints revisited, Extended ER diagram, Relational Algebra & Calculus, Functional, Multivalued and Join Dependency, Normal Forms, Rules about functional dependencies. Query Processing and Optimization: Valuation of Relational Operations, Transformation of Relational Expressions, Indexing and Query Optimization, Limitations of Relational Data Model Objected Oriented and Object Relational Databases: Modelling Complex Data Semantics, Specialization, Generalization, Aggregation and Association, Objects, Object Identity, Equality and Object Reference, Architecture of Object Oriented and Object Relational Databases Parallel and Distributed Databases: Distributed Data Storage-Fragmentation & Replication, Location and Fragment Transparency Distributed Query Processing and Optimization, Distributed Transaction Modeling and concurrency Control, Distributed Deadlock, Commit Protocols. Advanced Transaction Processing: Nested and Multilevel Transactions, Compensating Transactions, Weak Levels of Consistency, Transaction Work Flows and Transaction Processing Monitors. Active Database and Real Time Databases: Triggers in SQL, Multimedia Databases: Modeling and Storage of Image and Multimedia Data, Data Structures –R-tree, k-d tree, Quad trees, Content Based Retrieval, Geographic Information Systems (GIS) WEB Database: Accessing Databases through WEB, WEB Servers, XML Databases, Commercial Systems. Data Warehousing: Data Warehousing Architecture, Multidimensional Data Model, Update Propagation OLAP Queries. Data Mining: Knowledge Representation Using Rules, Association and Classification Rules, Sequential Patterns, Algorithms for Rule Discovery Case Study: Oracle Xi.

Recommended Book(s):

1. Elmarsi, Navathe, Somayajulu, Gupta, "Fundamentals of Database Systems", 4thEdition, Pearson Education, 2007
2. Garcia, Ullman, Widom, "Database Systems, The complete book", Pearson

Education, 2007

3. R. Ramakrishnan, "Database Management Systems", McGraw Hill International Editions, 1998
4. Date, Kannan, Swaminathan, "An Introduction to Database Systems", 8thEdition Pearson Education, 2007
5. Singh S.K., "Database System Concepts, design and application", Pearson Education, 2006.
6. Silberscatz, Korth, Sudarshan, "Database System Concepts", Mcgraw Hill, 6thEdition, 2006
7. D. Maier, "The Theory of Relational Databases", 1993, Computer Science Press, Rokville, Maryland
8. Ullman, J. D., "Principals of database systems", Galgotia publications, 1999, Oracle Xi Reference Manual

Course Code	Course Name	L-T-P	Credits
CS924	**Digital Image Processing**	3-0-0	3

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Understand fundamental steps of digital image processing.
CLO.2: Examine various types of images, intensity transformations and spatial filtering.
CLO.3: Understand, implement and compare various image enhancement techniques.
CLO.4: Implement and compare various image compression techniques.
CLO.5: Enabled skill to apply image processing algorithms in practical applications.

Course Outline:

Fundamentals of Image Processing: What is Digital Image Processing? Fundamental steps in Digital Image Processing, Application fields and Components of an image processing system. Digital Image Fundamentals: Elements of Visual Perception, Simple image formation model, Image Sampling and Quantization, Basic relationship between pixels, Linear and Non-Linear operations. Image Enhancement: Basic Gray level transformations, Histogram processing, Enhancement using Image subtraction and averaging. Basics of spatial and frequency domain filtering, Smoothing and sharpening filters. Homomorphic Filtering. Image Restoration: A Model of Image Degradation / restoration process. Algebraic approach to restoration: Inverse filtering, Minimum Mean Square Error (Wiener) Filtering. Image Restoration: A Model of Image Degradation / restoration process. Algebraic approach to restoration: Inverse filtering, Minimum Mean Square Error (Wiener) Filtering. Image Segmentation: Detection of Discontinuities, Point, Line and Edge detection, Edge linking and Boundary Detection, Thresholding, Region Based segmentation.: Basic geometric transformations: Introduction to Fourier Transform and DFT, FFT, Walsh-Hadamard Transform, Discrete Cosine Transform. Color Image Processing: Fundamentals, Color Models, Pseudo color Image Processing. Basics of full

color image processing, Color Transformations, Smoothening and Sharpening. Image Compression: Fundamentals, Lossless compression: Variable length coding, LZW coding, Bit plane coding, Lossless predictive coding, Lossy compression: Lossy Predictive Coding, Transform coding, Wavelet coding, Image & Video compression standards. Case Study: Morphological Image Processing: Dilation, erosion, Opening & Closing, Basic Morphological Algorithms.

Recommended Book(s):

1. Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, Pearson Education (2nd edition)
2. W.K. Pratt, "Digital Image Processing , "McGraw Hill, Second Editon
3. R.C. Gonzalez and R. E. Woods, "Digital Image Processing",:Addison Wesley/ Pearson Education, Second Editon.

Course Code	Course Name	L-T-P	Credits
CS925	**Digital Image Processing Lab**	**0-0-2**	1

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1:   Understand the installation of software

CLO.2:   Apply the technical skills like image segmentation, restoration etc

Course Outline:

To study fundamentals of image processing and write Programme to read and display different types of digital images.

To perform basic geometric transformations (2-D DFT, FFT etc.) on Digital Images.

To write Programme for zooming and shrinking of digital images and compare Nearest Neighbour interpolation, Bilinear interpolation and Bicubic interpolation methods of zooming.

To Perform enhancement in spatial domain on digital images and write programs for gray-level transformations, histogram processing and image averaging and subtraction.

To Perform Spatial Domain Enhancement using Filtration of digital images.

To Perform Frequency Domain Enhancement using Filtration of digital images.

To study and perform Image Restoration using Wiener Filters.

(i)To Perform erosion and dilation operation on the image

(ii)Use Morphological Closing to Fill Gaps in an Image and Morphologically Open Image with Disk-shaped Structuring Element

To perform detection of discontinuities: point, line and edges in a given image and study image Segmentation.

Recommended Book(s):

1. Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, Pearson Education (2nd edition)
2. W.K. Pratt, "Digital Image Processing , "McGraw Hill, Second Editon
3. R.C. Gonzalez and R. E. Woods, "Digital Image Processing",:Addison Wesley/ Pearson Education, Second Editon.

Course Code	Course Name	L-T-P	Credits
CS921	**Advanced Computer Networks**	**3-0-0**	**3**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Understand the main abstract concepts related to the layered communication architecture

CLO.2: Analyze and implement some of the most advanced routing and congestion control algorithms. Evaluate the performances of computer networks (through mathematical modeling and simulation).

CLO.3: Understand basics and principles of new generation of computer networking infrastructure (VoIP, SIP, RTP).

CLO.4: Practice Networking Simulating skills as employed in Industry for Planning and Design (CISCO Packet Tracer).

Course Outline:

Reference Models Introduction, Seven-Layer ISO-OSI architecture of networking, Concepts of Layer Protocols and Layer interface, TCP model with TCP/IP protocol stack, Comparison of ISO-OSI and TCP models, Topologies, mode of transfer, Guided Transmission Media, Wireless Transmission, Ethernet cabling standards (Cat-1, Cat-2, Cat-3, Cat-4, Cat-5, Cat-5e, Cat-6a), T-568A Straight-Through Ethernet Cable, T-568B Straight-Through Ethernet Cable. Error- Detection and Error-Correction numerical techniques (CRC, Hamming Code, Parity Bit, checksum), Elementary data link protocols -simplest, stop-and-wait protocol, sliding window protocols- 1-bit sliding window protocol, go back-n, selective repeat. Channel allocation, Multiple access protocols: random access (Aloha, Pure Aloha, slotted Aloha).IP protocol (IPv4 and IPv6), IP addresses (Classful and Classless), CIDR, Subnets, Supernetting VLSM, Routing algorithms (Static and Dynamic): Basic commands of Routers: hostname, password, Show Run, Show IP int brief, Assigning IP addresses to interfaces, Configuration of Static Routing, Configuration of Dynamic Routing: RIP V1 and RIP V2, Design and configuration of OSPF (Open Shortest Path First) in single area. Design and configuration of EIGRP Routing. WWW(world wide web), DNS(Domain Name System)-generic domain, country domain, inverse domain, SNMP(Simple Network Management Protocol), Cryptography-(Cryptographic Techniques, Computer-based Symmetric and Asymmetric Key Cryptographic Algorithms, Public Key Infrastructure (PKI), Internet Security Protocols, Network Security.), Firewalls, Digital Signature, Design and configuration of ACL: Standard and Extended, Design and Configuration of NAT (Network Address Translation): Static, Dynamic, PAT, Design and configuration of VPN Virtual private networks, Switching configuration concepts, Design and configuration of VLAN (Virtual Local Area Networks).

Recommended Book(s):

1. Data Communications and Networking' by Forouzan, Fourth edition.
2. Data and computer Communications' by William Stallings, 8th edition, Pearson.
3. CCNA study guide Sybex Publications by Todd Lammle.

Course Code	Course Name	L-T-P	Credits
CS922	**Advanced Computer Networks Lab**	**0-0-2**	**1**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Understand the captured data by using the relevant tools and focus on the involvement of layered approach in data transmission.

CLO.2: Enhance the analytical skills of the students to understand and simulate the working of TCP/IP reference model.

Course Outline:

Introduction of Cables, Network Devices: Hub, Switches, Router.

To design and perform IP addressing in network.

To design and implement peer to peer connectivity and share resources.

To design and implement a computer network demonstrating Star Topology.

Basic commands of Routers: hostname, password, Show Run, Show IP int brief, Assigning IP addresses to interfaces.

To design and simulate Static Routing.

To design and simulate Dynamic Routing: RIP V1 and RIP V2.

To design and simulate routing with OSPF (Open Shortest Path First) in single area.

To design and simulate EIGRP Routing.

To create and implement ACL: Standard and Extended.

To design and implement NAT (Network Address Translation): Static, Dynamic, PAT.

Recommended Book(s):

1. CCNA Study Guide by Sybex Publication
2. CCNA Preparation Guide by Cisco Press

Course Code	Course Name	L-T-P	Credits
RS991	Intellectual Property Rights and Publishing Research (I)	1-0-0	1

Course Learning Outcomes (CLO):

Students will be able to:

- CLO.1: Understand the Basics and Need of IPRs.
- CLO.2: Fill the invention disclosure form for patenting of an idea.
- CLO.3: Conduct the prior art to decide the patentability of the idea.
- CLO.4: Draft provisional/complete specifications of the patent application.
- CLO.5: Understand the challenges of the country in cause of promoting high quality research.
- CLO.6: Better appreciate the meaning of some basic terminologies related to general parameters used for gauging the research outcome.
- CLO.7: Use the Nature Master Class solution to their advantage, which will improve research paper writing skills.

Course Outline:

Introduction - Intellectual Property, Intellectual Property Rights, Categories of Intellectual Property, Rights protected under Intellectual Property, IPR as Instruments of Development, History of IPR in India, History of Copyright Law in India, History of Patent Law in India, History of Trademark Law in India Overview of Laws related to Intellectual Property Rights in India. Copyright – Introduction of Copyright, Copyright law in India Classes of works for which copyright protection is available, Ownership of Copyright, Assignment of copyright, Transmission of copyright by testamentary disposition, Relinquish copyright, Term of copyright, Rights of Broadcasting Organization and of Performers, Intellectual Property Rights (IPR) of Computer Software, Procedure of registration under copyright in India. Patent - Introduction to Patent, meaning of 'Invention' under Patent Law, what is not an 'Invention'? Patent system in India: what can be patented and what cannot be patented, Hierarchy of officers and jurisdiction of patent offices. Different types of patent applications, Precautions while patenting, Publication and Examination, Granting of patent, term and date of patent, Renewal and restoration, Rights of a Patentee, Compulsory license under Paris convention, Compulsory license under TRIPS, Patent Agent - Eligibility and criteria, Patent Infringement & penalties, E-filing of a patent in India. Trademark-What is Trademark? Features types and functions of a trademark, Trademarks law of India, who can apply for a trademark, How to file a trademark application for registration, Procedure for series registration and collective marks, Renewal of trademark, Offences and Penalties, Procedure of e-filing. Designs - What is Design, Design law in India, need for Registration of design, Exclusion from scope of design, Requirement for registration of Design, who can apply, Procedure for submission of application of registration, Cancellation, Piracy, Administration. Geographical Indications of Goods: What is a Geographical Indication? Laws relating to Geographical Indication of Goods Registration of Geographical Indication, Procedure for Filing application for registration of Geographical Indication, Infringement of Geographical Indication. Semiconductor Integrated Circuits Design: Semiconductor Integrated Circuits Layout-Design (SICLD) Act, 2000Criteria for registration of Chip Layout Design, Duration, Person entitled to protection of Layout-Designs,

steps for registration of a layout-design, Documents to be submitted along with application, Prohibition from registration, Penalties. Biological Diversity Biodiversity Act, 2002, Access to Biological Diversity, Exclusion under Biological Diversity Act, Penalty, National Biodiversity Authority. Protection of Plant Varieties and Farmer Rights Protection of Plant Varieties and Farmers' Right Act, 2001, Duration of protection of a registered plant variety, Registration of Plants, Application for registration, Criteria for registration of new variety, Prerequisites for filing an application form for registration of plant variety, Guidelines for submission of applications for Registration of Plant Varieties, Plant Authority (PPV&FR Authority). Undisclosed information- Introduction to Undisclosed Information. The agreement of trade related aspects of intellectual property rights (TRIPS). World intellectual property organization (WIPO) mission of WIPO, core tasks of WIPO, how WIPO works, WIPO goals. Intellectual property treaties - Paris convention for the protection of industrial property, Berne convention for the protection of literary and artistic works, the patent cooperation treaty (PCT), patent law treaty (PLT). Commercialization of intellectual property rights - commercialization of intellectual property rights by licensing, valuation of IPR, concept of IP valuation, methods of valuation.

Recommended Book(s):

1. Kompal Bansal and Parikshit Bansal, "Fundamentals of IPR for Engineers", B.S. Publications.
2. Cyber Law. Texts & Cases, South-Western's Special Topics Collections
3. Prabhuddha Ganguly, "Intellectual Property Rights", Tata Mc Graw Hill, New Delhi
4. www.ipindia.nic.in - Intellectual Property Office, India
5. www.patentoffice.nic.in – Patent office, India
6. http://copyright.gov.in/ - Copyright Office, India
7. ipr.icegate.gov.in – Automated Recordation & Targeting for IPR Protection
8. www.icegate.gov.in-E- Commerce portal of Central Board of Excise and Customs
9. www.ipab.tn.nic.in- Intellectual Property Appellate Board, India

Course Code	Course Name	L-T-P	Credits
RS992	**Intellectual Property Rights and Publishing Research (II)**	**1-0-0**	**1**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Appreciate the need of involving himself in cause of research.

CLO.2: Understand different aspects to improve research paper writing skills

CLO.3: Prepare a good summary of the literature survey carried out before starting to write a skilled research paper himself.

CLO.4: Full-fledged research paper which can submitted to flagship journals and conferences.

Course Outline:

How to file a patent, Academic integrity policy of UGC. Plagiarism/ similarity index and other ethical issues| Different tools and norms. 7 minutes presentation by students in groups on a particular research problem existing in research area of interest. Patent filing process in India, PCT filing process. Research paper improvisation and primitive evaluation.

Recommended Book(s):

1. Handbook on Intellectual Property Rights in INDIA by Rajkumar S. Adukia
2. Resources available on Nature Master Class website. www.masterclasses.nature.com
3. Cyber Law. Texts & Cases, South-Western's Special Topics Collections
4. Prabhuddha Ganguly, "Intellectual Property Rights", Tata Mc Graw Hill, New Delhi

Course Code	Course Name	L-T-P	Credits
CS908	Advanced DBMS	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Understand the functionality of the various database systems

CLO.2: Practice the codes and study about the case studies

CLO.3: Implement procedures, functions, cursors and triggers and become proficient in PL/SQL programming skills

Course Outline:

Relational Databases: Integrity Constraints revisited, Extended ER diagram, Relational Algebra & Calculus, Functional, Multivalued and Join Dependency, Normal Forms, Rules about functional dependencies. Query Processing and Optimization: Valuation of Relational Operations, Transformation of Relational Expressions, Indexing and Query Optimization, Limitations of Relational Data Model.

Objected Oriented and Object Relational Databases: Modeling Complex Data Semantics, Specialization, Generalization, Aggregation and Association, Objects, Object Identity, Equality and Object Reference, Architecture of Object Oriented and Object Relational Databases Parallel and Distributed Databases: Distributed Data Storage-Fragmentation & Replication, Location and Fragment Transparency Distributed Query Processing and Optimization, Distributed Transaction Modeling and concurrency Control, Distributed Deadlock, Commit Protocols.

Advanced Transaction Processing: Nested and Multilevel Transactions, Compensating Transactions, Weak Levels of Consistency, Transaction Work Flows and Transaction Processing Monitors. Active Database and Real Time Databases: Triggers in SQL, Multimedia Databases: Modeling and Storage of Image and Multimedia Data, Data Structures –R-tree, k-d tree, Quad trees, Content Based Retrieval, Geographic Information Systems (GIS)

WEB Database: Accessing Databases through WEB, WEB Servers, XML Databases, Commercial Systems. Data Warehousing: Data Warehousing Architecture, Multidimensional Data Model, Update Propagation OLAP Queries. Data Mining: Knowledge Representation Using Rules, Association and Classification Rules, Sequential Patterns, Algorithms for Rule

Discovery Case Study: Oracle Xi

Recommended Book(s):

1. Elmarsi, Navathe, Somayajulu, Gupta, "Fundamentals of Database Systems", 4[th]Edition, Pearson Education, 2007
2. Garcia, Ullman, Widom, "Database Systems, The complete book", Pearson Education, 2007
3. R. Ramakrishnan, "Database Management Systems", McGraw Hill International Editions, 1998
4. Date, Kannan, Swaminathan, "An Introduction to Database Systems", 8[th]Edition Pearson Education, 2007
5. Singh S.K., "Database System Concepts, design and application", Pearson Education, 2006.
6. Silberscatz, Korth, Sudarshan, "Database System Concepts", Mcgraw Hill, 6[th]Edition, 2006
7. D. Maier, "The Theory of Relational Databases", 1993, Computer Science Press, Rokville, Maryland
8. Ullman, J. D., "Principals of database systems", Galgotia publications, 1999
9. Oracle Xi Reference Manual

Course Code	Course Name	L-T-P	Credits
CS909	**Advanced Database Management Systems Lab**	**0-0-2**	**1**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Learn the installation of the software.

CLO.2: Design a commercial relational database system, skilled in Oracle, MySQL.

Course Outline:

Table Normalization & EER
● Creating Master Table
● Creating Transaction Tables
● Ensuring Null Integrity & Referential Integrity Constraints
● Testing Normal forms with Joins

Table Normalization & EER
● Creating Master Table
● Creating Transaction Tables
● Ensuring Null Integrity & Referential Integrity Constraints
● Testing Normal forms with Joins
● Drawing EER Diagrams

Study of EER diagram.
● Objective To get familiar with basic EER concepts

- (generalization and specialization)
- Study of ODL schema.
- To get familiar object structure, naming mechanism and ODL.

Implement Abstract data type.

- To get familiar User defined data types.
- Implement Varrays.
- V arrays help in storing repeating attributes of a record in a single row.
- Implement object Table.

Implement Nested tables.

- Implement Member procedure
- Implement Member Function.

Implement Partitioning on the tables.

- Implement XML command.

Course Code	Course Name	L-T-P	Credits
CS913	**Advanced Operating Systems**	**3-0-0**	**3**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Create Cloud using multiple operating systems simultaneously.
CLO.2: Detailed case study on Linux family.
CLO.3: Live experiments on concurrency, threads and deadlocks.
CLO.4: Administer the system using various Operating systems skills for managing its resources to create your own operating system.

Course Outline:

Architecture, Goals & Structures of O.S, Basic functions, Interaction of O. S. & hardware architecture, System calls, Batch, multiprogramming. Multitasking, time sharing, parallel, distributed & real -time O.S. Process Management Process Concept, Process states, Process control, Threads, Uni-processor Scheduling: Types of scheduling: Pre-emptive, Non pre-emptive, Scheduling algorithms: FCFS, SJF, RR, Priority, Thread Scheduling, Real Time Scheduling. System calls like ps, fork, join, exec family, wait. Concurrency control Concurrency: Principles of Concurrency, Mutual Exclusion: S/W approaches, H/W Support, Semaphores, pipes, Message Passing, signals, Monitors, Classical Problems of Synchronization: Readers-Writers, Producer Consumer, and Dining Philosopher problem. Deadlock: Principles of deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, System calls like signal, kill. Memory Management Memory Management requirements, Memory partitioning: Fixed and Variable Partitioning, Memory Allocation: Allocation Strategies (First Fit, Best Fit, and Worst Fit), Fragmentation, Swapping, and Paging. Segmentation, paging Virtual Memory: Concepts, management of VM, Page Replacement Policies (FIFO, LRU, Optimal, Other Strategies), Thrashing. I/O management &Disk scheduling: I/O Devices, Organization of I/O functions, Operating System Design issues, I/O Buffering, Disk Scheduling (FCFS, SCAN, C-SCAN, SSTF), RAID, Disk Cache. Inter Process Communication Basic Concepts of Concurrency, Co-operating process, Advantage of

Cooperating process, Bounded- Buffer -Shared-Memory Solution, Inter-process Communication (IPC), Basic Concepts of Inter-Process Communication and Synchronization. Multi-Processor Based and Virtualization Concepts Virtual machines; supporting multiple operating systems simultaneously on a single hardware platform; running one operating system on top of another. Reducing the software engineering effort of developing operating systems for new hardware architectures. True or pure virtualization. Para virtualization; optimizing performance of virtualization system; hypervisor call interface. Advanced Operating System Basics of Network Operating System, Server Operating System and Real Time Operating System.

Recommended Book(s):

1. Operating System Concepts, 9th edition Peter B. Galvin, Greg Gagne, Abraham

   Silberschatz, John Wiley & Sons, Inc.

2. Modern Operating Systems -By Andrew S. Tanenbaum (PHI) Operating Systems 5th

   Edition, William Stallings, Pearson Education India

Course Code	Course Name	L-T-P	Credits
CS903	**Cryptography & Network Security**	**4-0-0**	**4**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Identify common network security vulnerabilities/attacks.
CLO.2: Explain the foundations of Cryptography and network security
CLO.3: Critically evaluate the risks and threats to networked computers.
CLO.4: Demonstrate detailed knowledge of the role of encryption to protect data, skilled to analyze security issues.
CLO.5: Identify the appropriate procedures required to secure networks.

Course Outline:

Introduction to Security: Security Attacks – Types of attacks, Vulnerabilities. Access Control – Authentication and Authorization. Basics of Cryptography: Classical Encryption Techniques – Symmetric and Asymmetric cryptography. Substitution Techniques – Mono alphabetic ciphers, Polyalphabetic ciphers. Transposition Techniques: Block Ciphers and Stream Ciphers. Data Encryption Standard (DES), Strength of DES and Triple DES. AES, Overview of Block cipher modes of operation. Public-Key Cryptography: Principles of Public-Key Cryptosystems – The RSA Algorithm, Security of RSA. Key Management: Digital Certificates, PKI. Diffie-Hellman Key Exchange. Cryptographic Hash: Applications of cryptographic Hash Function, Properties of Hash Function. Hash Algorithms—MD5, Secure Hash Algorithm (SHA). MAC Algorithms—HMAC. Digital Signatures and authentication protocols – DSS – EI Gamal. Web Security: Kerberos and Secure Socket Layer. Electronic Commerce Security: Electronic Payment System, Secure electronic transaction (SET), Ecash (Digi cash). Electronics mail security: PRETTY GOOD PRIVACY (PGP), S/MIME. Intruders and Viruses: Networks

intrusion detection system (NIDS) and its role in Perimeter defence, Intrusion prevention systems (IPS) and its limitations, Viruses.

Recommended Book(s):

1. Network Security Essentials by William Stallings, 4th Edition, Pearson Publication
2. Applied Cryptography by Bruce Schneier, Edition 2001, Wiley& Sons Inc
3. Network security and Cryptography' by Bernard Menezes, Ist Edition, Cengage Learning Publication.

Course Code	Course Name	L-T-P	Credits
RS993	Research Methodology	3-0-0	3

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Start a carrier in research.

CLO.2: Can decide about various tools and techniques which will help them in research for analysis, ethics, presentation and writing a skilled research paper.

Course Outline:

Research: Meaning – Purpose- Types of research-significance of research. Collection of Data: Concept of Sample, Sample Size and Sampling Procedure, Various Types of Sampling Techniques. Determination and Selection of Sample Member, Types of Data- Secondary and Primary, Various Methods of Collection and Data, Preparation of Questionnaire and Schedule, Types of Questions, Sequencing of Questions, Check Questions, Length of Questionnaire, Precautions in Preparation of Questionnaire and Collection of Data. Analysis of Data-Coding, Editing and Tabulation of Data, Various Kinds of Charts and Diagrams Used in Data Analysis: Bar and Pie Diagrams and their Significance, Use of SPSS in Data Analysis, Application and Analysis of Variance (ANOVA). Measurement and Central Tendency, Measure of Dispersion and their Advantages. Report Preparation-Types and Layout of Research Report, Precautions in Preparing the Research Report. Bibliography and Annexure in the Report-Their Significance, Drawing Conclusions, Suggestions and Recommendations to the Concerned Persons. SPSS tool.

Recommended Book(s):

1. PanneerSelvam - Research Methodology (Prentice Hall of India, Edition 2008).
2. Kothari C R – Research Methodology Methods & Techniques (New Age International Publishers, 2nd Edition, 2004)

Course Code	Course Name	L-T-P	Credits
CS906	**Advanced Data Structures**	**3-0-0**	**3**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Learn the various data structures used.
CLO.2: Understand the data visualization and analytical skills.

Course Outline:

Introduction to Data Structures: Basic Terminology, Classification of data structures, operations on data structures, Abstract Data Types, Time and Space Complexity, Asymptotic Notations. Linear Data Structures: Array, Linked List, Stack and Queue. Trees: Introduction to trees, Binary Trees, Binary Search Trees, AVL Trees, Red-Black Trees, B Trees and B+ Trees. Heaps: Heaps, Binary Heaps, Binomial Heaps, Fibonacci Heaps, Comparison of Binary, Binomial, and Fibonacci Heaps, Applications of Heaps. Graphs: Graph Terminology, Directed Graphs, Bi-connected Components, Representation of Graphs, Graph Traversal Algorithms. Advance Topics in Data Structures: Introduction to Searching, Interpolation Search, Jump Search, Introduction to Sorting, Merge Sort, Quick Sort, Radix Sort, Heap Sort, Hashing and Collision, Memory Management in Data Structures.

Disjoint Sets – Equivalence relation, Basic Data Structure, Simple Union and Find algorithms, Smart Union and Path compression algorithm. String Matching – The naive string-matching algorithm, The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm.

Recommended Book(s):

1. Data Structures' by Schaums' Outlines Indian Adapted Edition 2006 by Seymour Lipschutz, Published by Tata McGraw-Hill Edition
2. Tanenbaum, Augenstein, & Langsam, Data Structures using C and C++, Prentice Hall of India, Second edition
3. Data structure Theory Problem in Algorithm by R.S Salaria, by Salaria Publisher
4. Data Structures in C by ReemaThareja , Oxford Publication, 3rd Edition
5. Fundamentals of Algorithm by Sahni and Horowitz 2nd Edition
6. Introduction to Algorithms by Coremen 3rd Edition

Course Code	Course Name	L-T-P	Credits
CS907	**Advanced Data Structures Lab**	**0-0-2**	**1**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Learn the installation of software.
CLO.2: Write loops, functions and pass arguments.

Course Outline:

Array, Array Traversing, Array Insertion, Array Deletion, Linked List Implementation, Creation, Insertion, Deletion and Traversal, Stack, Insertion and Deletion in stack using array, Insertion and Deletion in stack using linked list, Queue, Insertion and Deletion in queue using array, Insertion and Deletion in queue using linked list, Polish Notations, Infix to postfix, Infix to prefix, Evaluation of postfix, Sorting and Searching in an Array, Insertion Sort, Selection Sort, Linear Search, Binary Search, Multiple Stack Implementation, Multiple Queue Implementation,

An Invigilator was giving duty in an examination hall and the roll no list was fixed and students are sitting. Suddenly, one student came in the class by 10 minutes late and invigilator has to allow to sit the student according to his roll no. All the students are giving exam, one student started cheating and invigilator taken his sheet and tell him to leave the class. Implement the problem.

Manager of an organization wants to search the data of an employee from the database who take maximum leaves. In order to deduct the salary of that employee, manager searched the data according to the employee id from the list and get the data of that employee. Predict the output.

Write a program to find the closest pair of points using a divide and conquer strategy. Use the random number generator to generate a large number of points in a unit square as input to the algorithm. Test the correctness of the algorithm by using a brute force method.

Use dynamic programming to find the optimal binary search tree for a given set of numbers together with their probabilities. Remember that the numbers may be generated in any order, so, a presorting step is also required.

Recommended Book(s):

1. Data Structures' by Schaums' Outlines Indian Adapted Edition 2006 by Seymour Lipschutz, Published by Tata McGraw-Hill Edition
2. Tanenbaum, Augenstein, & Langsam, Data Structures using C and C++, Prentice Hall of India, Second edition
3. Data structure Theory Problem in Algorithm by R.S Salaria, by Salaria Publisher
4. Data Structures in C by ReemaThareja , Oxford Publication, 3rd Edition
5. Fundamentals of Algorithm by Sahni and Horowitz 2nd Edition
6. Introduction to Algorithms by Coremen 3rd Edition

Course Code	Course Name	L-T-P	Credits
CS910	Distributed Computing	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

- CLO.1: Develop and apply knowledge of parallel and distributed computing skills and methodologies.
- CLO.2: Apply design, development, and performance analysis of parallel and distributed applications.

CLO.3: Use the application of fundamental Computer Science methods and algorithms in the development of parallel applications.

CLO.4: Explain the design, testing, and performance analysis of a software system, and to be able to communicate that design to others.

CLO.5: Develop and apply knowledge of parallel and distributed computing techniques and methodologies.

Course Outline:

Introduction: What is Distributed Computing, Distributed Vs Parallel Computing, History, Characteristics and Need of Distributed Computing, Advantages and Disadvantages, Issues and Challenges, Distributed computing environment, Examples of Distributed Systems.

Distributed System Architecture: Introduction, Middleware, Client – server architectures, Layered Application architecture, Three-tier Architecture, Distributed Object Architecture, Peer-to-peer Architecture, Service Oriented architecture

Message Passing: Introduction, Inter process Communication, Desirable Features of Good Message Passing System, Issues in IPC by Message, Synchronization, Buffering, Multi-datagram Messages, Encoding and Decoding of Message Data, Process Addressing, Failure Handling, Group Communication.

Remote Procedure Calls: Introduction, Remote Procedure Call, Client and Server Stubs, RPC Issues, RPC Model, Marshalling Arguments, Asynchronous RPC, RPC Binding, Practical RPC Systems

Distributed Shared Memory: Introduction, Shared memory, issues of DSM, NUMA Multiprocessors, Granularity, Consistency Models, Replacement strategy, Thrashing

Synchronization: Introduction, Clock Synchronization, Event Ordering, Mutual Exclusion, Election Algorithms.

Resource Management: Introduction, Task assignment approach, Load Balancing approach, Load Sharing Approach, Process Migration, Process Management, Threads, Processor allocation, Real time distributed Systems.

Recommended Books:

1. "Distributed Systems: Principles and Paradigms", Andrew S. Tanenbaum, John Wiley & Sons.
2. "Distributed Operating Systems", Tanenbaum S., Pearson Education

Course Code	Course Name	L-T-P	Credits

CS911	Distributed Computing Lab	0-0-2	1

Course Learning Outcomes (CLO):

Students will be able to:

- CLO.1: Implement and apply knowledge of parallel and distributed computing skills and methodologies.
- CLO.2: Implement and design, development, and performance analysis of parallel and distributed applications.

Course Outline:

S. No. Experiment Detail

1-2 Implement concurrent echo client-server application

- Implement Client program
- Implement Server program

3-4 Implementation of Chat application using socket programming in Java

- Implement Chat Client
- Implement Chat Server

5-6

- Create RMI based server-client application
- Implement remote interface
- Implement the remote object by implementing the remote interface.
- Implement the client program.

7-8 Create RMI based server-client based Calculator application

- Implement remote interface
- Implement the remote object by implementing the remote interface.
- Implement the client program.

9-10 Create CORBA based server-client application

- Implement remote interface
- Implement the remote object by implementing the remote interface.
- Implement the client program.

Recommended Books:

1. "Distributed Systems: Principles and Paradigms", Andrew S. Tanenbaum, John Wiley & Sons.
2. "Distributed Operating Systems", Tanenbaum S., Pearson Education.

Elective I

Course Code	Course Name	L-T-P	Credits
CS951	Programming in C#	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Implement the concept of object-oriented techniques and methodologies using c#
CLO.2 Use Exception Handling concepts and skills for a Robust Application in c#.
CLO.3 Demonstrate an understanding of c# Input and Output
CLO.4 Develop applications using multithreading concept of c#.

Course Outline:

Understanding .NET: The C# Environment: The .Net Strategy, The Origins of .NET Technology, The .NET Framework, The Common Language Runtime, Framework Base Classes, User and Program Interfaces, Visual Studio .NET, .NET Languages, Benefits of the .NET Approach, C# and the .NET

Overview of C#: What is C#, Why C#, Evolution andCharacteristics of C#, Applications of C#, How does C# Differ from C++ and Java, Introduction to C# Program, Namespaces, Adding Comments, Main Returning a Value, Using Aliases for Namespace Classes, Passing String Objects to WriteLine Method, Command Line Arguments, Main with a Class, Providing Interactive Input, Using Mathematical Functions, Multiple Main Methods, Compile Time Errors, Program Structure, Program Coding Style

Literals, Variables and Data Types: Introduction to Literals, Variables, Data Types, Value Types, Reference Types, Declaration of Variables, Initialization of Variables , Default Values, Constant Variables, Scope of Variables, Boxing and Unboxing

Operators and Expressions: Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increment and Decrement Operators, Conditional Operator, Bitwise Operators, Special Operators, Arithmetic Expressions, Evaluation of Expressions, Precedence of Arithmetic Operators, Type Conversions, Operator Precedence and Associativity, Mathematical Functions

Decision Making and Branching: Decision Making with if Statement , Simple if Statement , The if... else Statement , Nesting of if....else Statements , The else if Ladder , The Switch Statement , The ? : Operator , The while Statement ,The do Statement , The for Statement , The foreach Statement , Jumps in Loops

Methods in C#: Declaring Methods , The Main Method , Invoking Methods, Nesting of Methods, Method Parameters , Pass by Value, Pass by Reference, The Output Parameters, Variable Argument Lists, Methods Overloading

Handling Arrays and Manipulating Strings: One-Dimensional Arrays , Creating an Array , Two-Dimensional Arrays , Variable-Size Arrays , The System. Array Class ,ArrayList Class, Creating Strings , String Methods , Inserting Strings , Comparing Strings , Finding Substrings , Mutable Strings , Arrays of Strings , Regular Expressions

Structures and Enumerations: Structures,Structs with Methods, Nested Structs, Differences between Classes and Structs, Enumerations, Enumerator Initialization , Enumerator Base

Types , Enumerator Type Conversion

Classes and Objects: Basic Principles of OOP , Defining a Class , Adding Variables , Adding Methods , Member Access Modifiers , Creating Objects , Accessing Class Members , Constructors , Overloaded Constructors , Static Members , Static Constructors , Private Constructors , Copy Constructors , Destructors , Member Initialization , The this Reference , Nesting of Classes , Constant Members , Read-only Members , Properties , Indexers

Inheritance and Polymorphism

Classical Inheritance , Containment Inheritance , Defining a Subclass , Visibility Control , Defining Subclass Constructors , Multilevel Inheritance , Hierarchical Inheritance ,Overriding Methods , Hiding Methods , Abstract Classes , Abstract Methods, Sealed Classes: Preventing Inheritance , Sealed Methods , Polymorphism

Interfaces: Multiple Inheritance and Operator Overloading: Defining an Interface , Extending an Interface , Implementing Interfaces , Interfaces and Inheritance , Explicit Interface Implementation, Abstract Class and Interfaces, Overloadable Operators, Need for Operator Overloading, Defining Operator Overloading , Overloading Unary Operators ,Overloading Binary Operators , Overloading Comparison Operators

Delegates and Managing Console I/O Operations: Delegates , Delegate Declaration , Delegate Methods , Delegate Instantiation , Delegate Invocation , Using Delegates , Multicast Delegates , Events, The Console Class, Console Input, Console Output, Formatted Output, Numeric Formatting, Standard Numeric Format, Custom Numeric Format

Windows and Web-based Application Development on .NET: Understanding Microsoft Visual Studio, Creating and Running a SampleWinApp Windows Application, Creating and Running a SampleWinApp2 Windows Application, Web-based Application on .NET

Recommended Books:
1. Jesse Liberty, "Programming C#", Second Edition, O'Reilly Press, 2002.
2. SvetlinNakov& Co., "Fundamentals of Computer Programming With C# ", 2013.

Course Code	Course Name	L-T-P	Credits
CS952	**Programming in Python**	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Run basic python programs.

CLO.2 Use python skills in various fields of Data Science, Machine Learning and Artificial Intelligence.

CLO.3 Logic building using looping and decision statements.

CLO.4 Develop problem solving abilities using Python.

CLO.5 Learn building packages and modules for reusability.

CLO.6 Learn GUI development using Widgets in Python.

Course Outline:

Introduction: Variables, expressions, and statements: Values and types, Variables, Variable names and keywords, Statements, Operators and operands, Expressions. Order of operations, Expressions, Order of operations, Modulus operator, String operations, Asking the user for input, Comments, Choosing mnemonic variable names.

Conditional execution: Boolean expressions, Logical operators, Conditional execution, Alternative execution, Chained conditionals, Nested conditionals, catching exceptions using try and except, Short-circuit evaluation of logical expressions.

Functions: Function calls, Built-in functions, Type conversion functions, Random numbers, Math functions, Adding new functions, Definitions and uses, Flow of execution, Parameters and arguments. Flow of execution, Parameters and arguments.

Iteration: Updating variables, while statement, Infinite loops, "Infinite loops" and break, Finishing iterations with continue, Definite loops using for, Loop patterns.

Strings: Intoduction, Getting the length of a string using len, Traversal through a string with a loop, String slices, Strings are immutable, Looping and counting, The in operator, String comparison, string methods, Parsing strings, Format operator.

Files: Persistence, Opening files, Text files and lines, Reading files Searching through a file, Using try, except, and open, Writing files.

Lists, tuples and dictionaries: list operators, replacing, inserting, removing an element searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries.

Classes and OOP: classes, objects, attributes and methods; defining classes; design with classes, data modeling; persistent storage of objects, inheritance, polymorphism, operator overloading (_eq_,_str_, etc); abstract classes; exception handling, try block.

Python is open source – Python is developed under an OSI-approved open source license, making it freely usable and distributable, even for commercial use. Python's license is administered by the Python Software Foundation.

Recommended Books:
1. "Programming in Pyhton: A complete introduction to the python Language(second edition)", Mark Summerfield, ISBN:978-0-321-68056-3(pbk: all paper).
2. "Core Pyhton Programming", Wesley.J.Chun (First edition), ISBN: 0-13-0260-36-3, 816 pages

Course Code	Course Name	L-T-P	Credits
CS953	Programming in R	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Use R skills in various fields of Data Science, Machine Learning and Artificial Intelligence.

CLO.2 Logic building using looping and decision statements.

CLO.3 Develop problem solving abilities using R

CLO.4 Learn building packages and modules for reusability.

CLO.5 Learn GUI development using Widgets in R.

Course Outline:

Basic R features; introduction to the main data types and visualization, More on vectors and other data types

Introduction to functions. More on lists and data frames, Programming structures: relational and logical operations; flow control, Environment and scope, more on data frames

Math and simulations in R, Debugging, introduction to strings and regular expressions

Introduction to graphics, the Grammar of Graphics, Data shaping and transformation; split-transform-recombine, Reshaping and tidying data, exploring large data sets

Dates and times, statistical models in R, Overview of main domain-specific libraries, TBA

Project using R.

Recommended Books:

1. Benjamin M. Bolker. Ecological Models and Data in R. Princeton University Press, 2008. ISBN 978-0-691-12522-0.
2. Peter Dalgaard. Introductory Statistics with R. Springer, 2nd edition, 2008. ISBN 978-0-387-79053-4.
3. Brian Everitt and TorstenHothorn. A Handbook of Statistical Analyses Using R. Chapman & Hall/CRC, BocaRaton, FL, 2006. ISBN 1-584-88539-4.
4. John Maindonald and John Braun. Data Analysis and Graphics Using R. Cambridge University Press, Cambridge, 2nd edition, 2007. ISBN 978-0-521-86116-8.

Elective II

Course Code	Course Name	L-T-P	Credits
CS954	**Advanced Programming in Java**	**4-0-0**	**4**

Course Learning Outcomes:

Students will be able to:

CLO.1 Design thewebsite.
CLO.2 Develop project using Spring framework skill.
CLO.3 Maintain and enhanceexisting web platform.
CLO.4 Implement several Data structures using Collection Framework.
CLO.5 Use database connectivity for a complete Java application.

Course Outline:

Getting Started with Java, Conditionals and Loops, Operators and For Loop, Functions, Variab les andtheir scope, Arrays, Searching and Sorting, Strings and 2D-Arrays, Object Oriented Programming, Recursion, Time and Space Complexity, Linked List, Stack and Queues, Trees (Binary   Trees) and Binary Search Trees), Hash Maps, Priority Queues, Tries and Huffman Coding, Dynamic P rograming,Graphs.

Recommended Book(s):

1. Schildl, Herbert. (2015). The Complete Reference Java. (8th ed). McGraw Hill Education India.
2. Lipschutz, Seymour. (2010). Schaum Data Structures Outline. (2nd ed). Tata McGraw-Hill.
3. Sierra, Kathy. (2009). Head First Java. (2nd ed).Pearson.
4. Finegan, Edward G.(2014).OCA Java SE8 Programmer I Study Guide. (3rd ed). Oracle Press.

Course Code	Course Name	L-T-P	Credits
CS955	**Virtual Private Network**	**4-0-0**	**4**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Use highly secure VPN communications, with access rights tailored to individual users
CLO.2 USe VPN products to add new sites or users, without significantly expanding your existing infrastructure
CLO.3 Extend skills of corporate networks, applications, and collaboration tools by using VPN
CLO.4 Reduce communications costs while increasing flexibility

Course Outline:

Introduction to VPN:Understanding VPNs, Evolution of VPNs,VPN Tunneling Protocols, Advantages and Disadvantages of VPNs
VPN Considerations, Types of VPNs, Remote Access VPNs, Intranet VPNs, Extranet VPNs
VPN Requirements, Building Blocks, and Architectures: VPN Requirements: Security,Availability and Reliability Quality of Service, Manageability, Compatibility
Building Blocks of a VPN, VPN Hardware, VPN Software
Security Infrastructure of the Organization, Service Provider's Supporting Infrastructure, Public Networks
VPN Architectures, Implementer-based VPN Architectures, Security-based VPN Architectures, Layer-based
VPN Architectures, Class-based VPN Architectures
Layer-based VPN Architectures, Class-based VPN Architectures
User Authentication and Access Control, Authenticating Users, Controlling Access, Encrypting Data
Symmetric Cryptosystems, Asymmetric Cryptosystems
Public Key Infrastructure
PKI Components, PKI-based Transactions, Implementing PKI

Recommended Books

1. Steven Brown, "Implement Virtual Private Networks," McGraw-Hill, May 1999.
2. Catherine Paquet, Cisco Systems Inc., " Building Cisco Remote Access Networks," Cisco Press, August 1999.
3. http://sites.inka.de/sites/bigred/devel/cipe.html
4. http://www.bitpipe.com/tlist/VPN.html

Course Code	Course Name	L-T-P	Credits
CS956	Biometric Security	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Apply biometric matching for identification
CLO.2 Identify algorithms for finger biometric technology
CLO.3 Apply skills of facial biometrics for identification.
CLO.4 Apply iris biometric, voice biometric, physiological biometrics etc. for identification.

Course Outline:

Biometrics- Introduction- benefits of biometrics over traditional authentication systems - benefits of biometrics in identification systems-selecting a biometric for a system – Applications - Key biometric terms and processes - biometric matching methods -Accuracy in biometric systems.

Physiological Biometric Technologies: Fingerprints - Technical description –characteristics - Competing technologies - strengths – weaknesses – deployment - Facial scan - Technical description - characteristics - weaknesses-deployment - Iris scan - Technical description – characteristics - strengths – weaknesses – deployment - Retina vascular pattern

Technical description – characteristics - strengths – weaknesses – deployment - Hand scan - Technical description-characteristics - strengths – weaknesses deployment – DNA biometrics. Behavioral Biometric Technologies: Handprint Biometrics - DNA Biometrics.

Signature and handwriting technology - Technical description – classification – keyboard / keystroke dynamics- Voice – data acquisition - feature extraction - characteristics - strengths – weaknesses-deployment.

Multi biometrics and multi factor biometrics - two-factor authentication with passwords - tickets and tokens – executive decision - implementation plan.

Recommended Books:
1. Samir Nanavathi, Michel Thieme, and Raj Nanavathi : "Biometrics -Identity verification in a network", 1st Edition, Wiley Eastern, 2002.
2. John Chirillo and Scott Blaul : "Implementing Biometric Security", 1st Edition, Wiley Eastern Publication, 2005.
3. John Berger: "Biometrics for Network Security", 1st Edition, Prentice Hall, 2004.

Course Code	Course Name	L-T-P	Credits

CS957	**Software Testing and Quality Assurance**	**4-0-0**	**4**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Understand software testing and quality assurance as a fundamental component of software life cycle

CLO.2 Infer various software models concepts and skills for making the software.

CLO.3 Analyse software creating requirements to determine the entities involved in the system and their relationship to one another.

CLO.4 To make sure that the result meets the business and user requirements Software testing plays an instrumental role.

CLO.5 Also, to satisfies the BRS that is Business Requirement Specification and SRS that is

Course Outline:

System Requirement Specifications and finally gain the confidence of the customers by providing them a quality product.

Software Quality: What is Quality? Five Views of Software Quality, McCall's Quality Factors and Criteria, Quality Factors, Quality Criteria, Relationship between Quality Factors and Criteria, Quality Metrics, ISO 9126 Quality Characteristics, ISO 9000:2000 Software Quality Standard, ISO 9000:2000 Fundamentals, ISO 9001:2000 Requirements

Software Quality Assurance Framework and Standards SQA Framework:

Software Quality Assurance, Components of Software Quality Assurance system, Costs of Software Quality, Quality Management Standards, Management and its role in Software Quality Assurance, SQA unit and other factors in SQA system

Quality Standards: ISO 9000 and Companion ISO Standards, CMM, CMMI, PCMM, Malcom Balridge, 3 Sigma, 6 Sigma

Software Quality Assurance Metrics and Measurement: Software Quality Metrics: Product Quality metrics, In-Process Quality Metrics, Metrics for Software Maintenance, Examples of Metric Programs, Collecting Software Engineering Data

Software Testing Strategy: Software test classifications, Classification according to testing concept, Classification according to requirements, White box testing, Data processing and calculation correctness tests, Correctness tests and path coverage, Correctness tests and line coverage, McCabe's cyclomatic complexity metrics, Software qualification and reusability testing, Advantages and disadvantages of white box testing, Black box testing, Equivalence classes for output correctness tests, Other operation factor testing classes, Revision factor testing classes, Transition factor testing classes, Advantages and disadvantages of black box testing

Software Testing Implementation: The testing process, Determining the test methodology phase, Planning the tests, Test design, Test implementation, Test case design, Test case data components, Test case sources, Automated testing, The process of automated testing, Types of automated tests and disadvantages of automated tests, Alpha and beta site testing programs

Testing tools: Taxonomy of Testing tools, Methodology to evaluate automated testing tools, Load Runner, Win runner and Rational Testing Tools, Silk test, Java Testing Tools, JMetra, JUNIT and Cactus.

Software Testing Process: Cost of computer testing, Seven step software Testing Process, Define the scope of testing, Developing the test plan, Verification Testing. Validation Testing, Analysing and reporting test results, Acceptance and operational Testing, Post Implementation Analysis.

Recommended Books:

1. 'Software Testing and Quality Assurance: Theory and Practice' by Sagar Naik, University of Waterloo, Piyus Tripathy, Wiley, 2008.
2. William E.Perry: Effective Methods for Software Testing, 3rd Edition, Wiley Publication,2009.
3. Mordechai Ben-Menachem,Garry S. Marliss: Software Quality,1st Edition, Thomson Learning Publication, 2008

Course Code	Course Name	L-T-P	Credits
CS958	**S/W Project Management**	**4-0-0**	**4**

Course Learning Outcomes:

Students will be able to:

CLO.1 To acquire presentation and communication skills

CLO.2 Undertake problem identification, formulation and solution to make students employable.

CLO.3 Design engineering solutions to complex problems utilizing a systems approach

CLO.4 To implement learning in real life problem for skill development

CLO.5 To propose multiple solution to any given problem and find best out of those.

Course Outline:

Tools and Techniques: software project planning, Understand the Project Needs, Create the Project Plan, Diagnosing Project Planning Problems

Estimation: Elements of a Successful Estimate, Wideband Delphi Estimation, Other Estimation

Techniques, Diagnosing Estimation Problems

Project Schedules: Building the Project Schedule, Managing Multiple Projects, Use the Schedule to Manage Commitments, Diagnosing Scheduling Problems,

Reviews: Inspections, Deskchecks, Walkthroughs, Code Reviews, Pair Programming, Use Inspections to Manage Commitments, Diagnosing Review Problems

Software Requirements: Requirements Elicitation, Use Cases, Software Requirements Specification Change Control, Introduce Software Requirements Carefully, Diagnosing Software Requirements Problems

Design and Programming: Review the Design, Version Control with Subversion, Refactoring, Unit Testing, Use Automation, Diagnosing Design and Programming Problems

Software Testing: Test Plans and Test Cases, Test Execution, Defect Tracking and Triage, Test Environment and Performance Testing, Smoke Tests, Test Automation, Postmortem Reports, Using Software Testing Effectively, Diagnosing Software Testing Problems

Understanding Change: Why Change Fails, how to Make Change Succeed

Management and Leadership: Take Responsibility, Manage the Organization, Manage Your Team

Managing an Outsourced Project: Prevent Major Sources of Project Failure, Management Issues in Outsourced Projects, Collaborate with the Vendor

Process Improvement: Life Without a Software Process, Software Process Improvement

Introduction to UML: Object-Oriented Analysis and Design with Use-Case View, Different types of views in UML, Use-Case Diagrams, Creating Use Cases, Class Diagrams, Finding Classes, Discovering Object Interaction, Specifying Relationships, Object Diagrams, Software Design and Software Engineering, The Design Process, Design Principles, Design Concepts, Effective Modular Design, Design Concepts and Principles with UML, Collaboration Diagrams, Sequence Diagrams, State Diagrams,

Activity Diagrams, Component Diagrams and Deployment Diagrams.

Recommended Books:

1. Applied Software Project Management, Andrew Stellman and Jennifer Greene, O'Reilly Media

Course Code	Course Name	L-T-P	Credits
CS959	**Cloud Computing and Virtualization**	**4-0-0**	**4**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1   Students will be able to identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.

CLO.2   Students will be able to explain the core issues of cloud computing such as security, privacy, and interoperability.

CLO.3   Students will be able to identify problems, and explain, analyze, and evaluate various cloud computing solutions.

CLO.4   Students will be able to provide the appropriate cloud computing solutions and recommendations according to the applications used.

CLO.5   Students will be able to build skills to generate new ideas and innovations in cloud computing.

Course Outline:

Introduction to Cloud Computing: Components of a computing cloud, Differentiating types of clouds: public, private, hybrid, delivering services from the cloud,Categorizing service types, Comparing vendor cloud products: Amazon, Google, Microsoft and others. Cloud Types: The NIST model, The Cloud Cube Model. Understanding Cloud Architecture: Exploring the Cloud Computing Stack, Infrastructure, Platforms

Virtual Appliances, Communication Protocols, Applications.

Exploiting SaaS, PaaS and IaaS: Characterizing SaaS-Minimizing the need for local hardware and software, streamlining administration with centralized installation and updates,

Optimizing cost and performance with the ability to scale on demand. Comparing service scenarios-Improving collaboration with business productivity tools, Simplifying business process creation by integrating existing components. Inspecting SaaS technologies-Deploying Web applications, Implementing Web services: SOAP, REST, Choosing a development platform, exploring the technical foundation for PaaS-Specifying the components of PaaS, Analyzing vendor PaaS provisions, selecting an appropriate implementation. Building services with solution stacks-Evaluating the architecture of vendor specific platforms, Becoming familiar with service platform tools, leveraging the power of scalable middleware, Enabling technologies-Scalable server clusters, Achieving transparency with platform virtualization, Elastic storage devices.

Building a Business Case: Calculating the financial implications:-Analyzing current and future computing requirements, Comparing in-house facilities to the cloud, Estimating economic factors downstream.

Virtualization: Introduction to virtualization platforms, Hypervisors: Types of hypervisors, hosted and bare metal hypervisors, WSX utility, Esxi implementation, V client and V cloud Director, Connecting and maintaining remote virtual machines, Introduction to amazon web services, EC2, configuring and managing a virtual machine, making clone of virtual machine, sharing and uploading of virtual machines over remote servers.

Preserving business continuity: Selecting appropriate service-level agreements, safeguarding access to assets in the cloud, Security, availability and disaster recovery strategies

Migrating to the Cloud: Technical considerations- Re-architecting applications for the cloud, Integrating cloud with existing applications .Avoiding vendor lock-in, planning the migration-Incremental vs. one-step solution, selecting a vendor, establishing staff skill requirements.

Recommended Books:
1. Architecting the Cloud by Michael J. Kavis
2. Cloud Computing Bible by Barrie Sosinsky
3. Cloud Computing- The Complete Cornerstone Guide to Cloud Computing Best practices.

Course Code	Course Name	L-T-P	Credits
CS960	Natural Language Processing	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Learn the basic concepts and skills of Artificial Intelligence.
CLO.2 Represent Knowledge using propositional calculus and predicate calculus.
CLO.3 Use inference rules to produce predicate calculus expression.
CLO.4 Demonstrate awareness of informed search and uninformed search techniques.
CLO.5 Explain about AI techniques for planning, knowledge representation and management.
CLO.6 Outline the process involved in Expert systems and in building such systems.

Course Outline:

Introduction and Overview What is Natural Language Processing, hands-on demonstrations. Ambiguity and uncertainty in language. The Turing test. Regular Expressions Chomsky hierarchy, regular languages, and their limitations. Finite-state automata. Practical regular expressions for finding and counting language phenomena. A little morphology. Exploring a large corpus with regex tools. Programming in Python An introduction to programming in Python. Variables, numbers, strings, arrays, dictionaries, conditionals, iteration. The NLTK (Natural Language Toolkit) String Edit Distance and Alignment Key algorithmic tool: dynamic programming, a simple example, use in optimal alignment of sequences. String edit operations, edit distance, and examples of use in spelling correction, and machine translation.

Context Free Grammars Constituency, CFG definition, use and limitations. Chomsky Normal Form. Top-down parsing, bottom-up parsing, and the problems with each. The desirability of combining evidence from both directions Non-probabilistic Parsing Efficient CFG parsing with CYK, another dynamic programming algorithms. Early parser. Designing a little grammar, and parsing with it on some test data. Probability Introduction to probability theory Joint and conditional probability, marginals, independence, Bayes rule, combining evidence. Examples of applications in natural language. Information Theory The "Shannon game"--motivated by language! Entropy, crossentropy, information gain. Its application to some language phenomena.

Language modeling and Naive Bayes Probabilistic language modeling and its applications. Markov models. N-grams. Estimating the probability of a word, and smoothing. Generative models of language. Part of Speech Tagging and Hidden Markov Models, Viterbi Algorithm for Finding Most Likely HMM Path Dynamic programming with Hidden Markov Models, and its use for part-of-speech tagging, Chinese word segmentation, prosody, information extraction, etc.

Probabilistic Context Free Grammars Weighted context free grammars. Weighted CYK. Pruning and beam search. Parsing with PCFGs A tree bank and what it takes to create one. The probabilistic version of CYK. Also: How do humans parse? Experiments with eye-tracking. Modern parsers. Maximum Entropy Classifiers The maximum entropy principle and its relation to maximum likelihood. Maximum entropy classifiers and their application to document classification, sentence segmentation, and other language tasks

Maximum Entropy Markov Models & Conditional Random Fields Part-of-speech tagging, noun-phrase segmentation and information extraction models that combine maximum entropy and finite-state machines. State-of-the-art models for NLP. Lexical Semantics Mathematics of Multinomial and Dirichlet distributions, Dirichlet as a smoothing for multinomial's. Regulations Information Extraction & Reference Resolution- Various methods, including HMMs.

Recommended Books:
1. "Speech and Language Processing": Jurafsky and Martin, Prentice Hall
2. "Statistical Natural Language Processing"- Manning and Schutze, MIT Press
3. "Natural Language Understanding". James Allen. The Benajmins/Cummings Publishing Company Cover, T. M. and J. A. Thomas: Elements of Information Theory. Wiley.
4. Charniak, E.: Statistical Language Learning. The MIT Press.
5. Jelinek, F.: Statistical Methods for Speech Recognition. The MIT Press. 4. Lutz and Ascher - "Learning Python", O'Reilly

Course Code	Course Name	L-T-P	Credits
CS961	**Pattern Recognition**	**4-0-0**	**4**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Understand and gain skills of basic concepts in pattern recognition
CLO.2 Gain knowledge about state-of-the-art algorithms used in pattern recognition research
CLO.3 Understand pattern recognition theories, such as Bayes classifier, linear discriminant analysis.
CLO.4 Apply pattern recognition techniques in practical problems.

Course Outline:

PATTERN RECOGNITION OVERVIEW Pattern recognition, Classification and Description—Patterns and feature Extraction with Examples—Training and Learning in PR systems—Pattern recognition Approaches

STATISTICAL PATTERN RECOGNITION Introduction to statistical Pattern Recognition—supervised Learning using Parametric and Non Parametric Approaches.

LINEAR DISCRIMINANT FUNCTIONS AND UNSUPERVISED LEARNING AND CLUSTERING (9 hours) Introduction—Discrete and binary Classification problems—Techniques to directly Obtain linear Classifiers -- Formulation of Unsupervised Learning Problems—Clustering for unsupervised learning and classification.

SYNTACTIC PATTERN RECOGNITION Overview of Syntactic Pattern Recognition—Syntactic recognition via parsing and other grammars–Graphical Approaches to syntactic pattern recognition—Learning via grammatical inference.

NEURAL PATTERN RECOGNITION Introduction to Neural networks—Feedforward Networks and training by Back Propagation—Content Addressable Memory Approaches and Unsupervised Learning in Neural PR.

Recommended Books:

1. Robert Schalkoff, "Pattern Recognition: Statistical Structural and Neural Approaches", John wiley&sons , Inc,1992.
2. Earl Gose, Richard johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall of India,.Pvt Ltd, New Delhi, 1996.
3. Duda R.O., P.E.Hart& D.G Stork, " Pattern Classification", 2nd Edition, J.WileyInc 2001.
4. Duda R.O.& Hart P.E., "Pattern Classification and Scene Analysis", J.wileyInc, 1973.
5. Bishop C.M., "Neural Networks for Pattern Recognition", Oxford

Course Code	Course Name	L-T-P	Credits

CS962	**Next Generation Wireless and Sensor Networks**	**4-0-0**	**4**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Implement skill based knowledge of routing mechanisms and the three classes of approaches: proactive, on-demand, and hybrid

CLO.2 Study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.

CLO.3 Identify the issues and challenges in providing QoS

CLO.4 Explain about the energy management in ad-hoc networks

CLO.5 Demonstrate various types of mesh networks.

Course Outline:

Wireless Network Architecture: Wireless Network Logical Architecture; Network Layer Technologies; Data Link Layer Technologies; Physical Layer Technologies; Wireless Communication; RF Spectrum; Wireless Multiplexing and Multiple Access Techniques; Wireless LAN Standards; Implementing Wireless LANs; Implementing Wireless PANs; WLAN Security Measures; Troubleshooting using WLAN Analyzers.

The Future of Wireless Networking Technology: Wireless Mesh Network Routing; Network Independent Roaming; Gigabit Wireless LANs; Cognitive Radio; ZigBee; DASH7; RuBee; EnOcean; 6LoWPAN; Wireless USB; Ofcom and 5G; Li-Fi.

Motivation for a Network of Wireless Sensor Nodes: Definitions and Background, Challenges and constraints; Applications of wireless sensor networks; Node Architecture; The Sensing Subsystem - Analog-to-Digital Converter; The Processor Subsystem; Communication Interfaces; Prototypes.

Medium Access Control: Wireless MAC Protocols; Characteristics of MAC Protocols in Sensor Networks; Contention-Free MAC Protocols; Contention-Based MAC Protocols; Hybrid MAC Protocols

Network Layer: Routing Metrics; Flooding and Gossiping; Data-Centric Routing; Proactive Routing; On-Demand Routing; Hierarchical Routing; Location-Based Routing; QoS-Based Routing Protocols

Transport Layer: Traditional Transport Control Protocols; Transport Protocol Design Issues; Examples of Existing Transport Control Protocols; Performance of Transport Control Protocols

Power Management & Time Synchronization: Local Power Management Aspects; Dynamic Power Management; Conceptual Architecture; Clocks and the Synchronization Problem; Time Synchronization in Wireless Sensor Networks; Basics of Time Synchronization; Time Synchronization Protocols.

Sensor Network Programming: Challenges in Sensor Network Programming; Node-Centric Programming; Macroprogramming; Dynamic Reprogramming; Sensor Network Simulators.

Recommended Book(s):

1. C. S. Raghavendra, Krishna M. Sivalingam and TaiebZnati, "Wireless sensor networks", kluwer academic publishers.
2. Feng Zhao and Leonidas J. Guibas, "Wireless Sensor Networks: An Information Processing Approach", Elsevier.
3. Robert Faludi, "Building Wireless Sensor Networks", O'Reilly.
4. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John wiley and sons.
5. JYH – CHENG CHEN, TAO ZHANG, "IP – Based Next Generation Wireless Networks (Systems, Architectures and Protocols)", Wiley.
6. Rajeev Shorey, A. Ananda, MunChoon Chan and Wei Tsang Ooi, "Mobile, wireless, and
7. Sensor networks - technology, applications, and future directions", Wiley.

Elective III

Course Code	Course Name	L-T-P	Credits
CS963	**Big Data Analytics**	**4-0-0**	**4**

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Understand and implement classical models and algorithms in machine learning as well as python programming concepts.
CLO.2 Analyze the data, identify the problems
CLO.3 Learn the skills to analyze relevant models and algorithms to turn available data into valuable and useful Information.
CLO.4 Understand the comparative study of the related approaches.
CLO.5 Explore new techniques and ideas that can be used to improve the effectiveness of current AI tools.

Course Outline:

Big Data: Why and Where: Big Data landscape including examples of real world big data problems including the three key sources of Big Data: people, organizations, and sensors.
Characteristics of Big Data and Dimensions of Scalability:Explain the V's of Big Data (volume, velocity, variety, veracity, valence, and value) and impact of each characteristic on data collection, monitoring, storage, analysis and reporting.
Data Science: Getting Value out of Big Data: Getting value out of Big Data by using a 5-step process to structure your analysis.
Foundations for Big Data Systems and Programming: Explanation of the architectural components and programming models used for scalable big data analysis.
Systems: Getting Started with Hadoop: Summarization of the features and value of core Hadoop stack components including the YARN resource and job management system, the HDFS file system and the MapReduce programming model. Installation and running a program using Hadoop.

Recommended Books:

1. Understanding Big Data by Chris Eaton, Paul Zikopoulos
2. Mining of Massive Datasets by Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman

Course Code	Course Name	L-T-P	Credits
CS964	Soft Computing	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Learn about soft computing skills and techniques of their applications
CLO.2 Analyze various neural network architectures
CLO.3 Understand perceptrons and counter propagation networks.
CLO.4 Define the fuzzy systems
CLO.5 Analyze the genetic algorithms and their applications.

Course Outline:

Intelligent Agents: Agents Behavior and Environments, Structure of Agents, Planning Problem, Planning with state Space Search, Partial order Planning, GRAPHPLAN, Planning in logic, Planning in non-deterministic domains, hierarchical task planning, Multi agent planning, execution.

Probabilistic Reasoning Fuzzy Logic: Knowledge representation under uncertainty, Bayesian theorem, Bayesian Networks, Dempster Shafer theory, Representing vagueness, Fuzzy sets, operation on fuzzy sets, reasoning with fuzzy logic, Fuzzy Automata, Fuzzy Control methods, Fuzzy decision making, inference in temporal models, Hidden Markov Models, Kalman Filters.

Neural Networks: Basic concepts, Single layer perception, Multilayer Perception, Supervised and Unsupervised learning - Backpropagation networks - Kohnen'sself organizing networks - Hopfield network. Introduction to Artificial Neural Systems - Perceptron - Representation - Linear separability - Learning – Training algorithm -Adaptive networks based Fuzzy interface systems - Classification and Regression Trees - Data clustering algorithms - Rule based structure identification - Neuro-Fuzzy controls - Simulated annealing. Genetic Algorithms: Evolutionary computation. Survival of the Fittest - Fitness Computations - Cross over – Mutation, Reproduction - Rank method - Rank space method

Recommended Book:

1. Stuart J.Russel, Norvig : AI: A Modern Approach, Pearson Education, Latest Edition
2. Michael Negnevitsky : Artificial Intelligence: A Guide to Intelligent Systems, 2/E, Addison-Wesley, 2005
3. YegnanarayanaB : Artificial Neural Networks, Prentice Hall of India Private Ltd., New Delhi, 1999.
4. Hagan, M.T., Demuth, Mark Beale : Neural Network Design By Cengage Learning
5. Goldberg, David E. : Genetic algorithms in search, optimization and machine learning, Latest Edition, Addison Wesley

Course Code	Course Name	L-T-P	Credits

CS9643	Communication Network and Protocols	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Skilled to use and implement internet technology

CLO.2 To understand the functioning of Frame Relay, ATM. and security issues related to data communication in networks

Course Outline:

This course will enable students on fundamental understanding of basic network design, routing, dimensioning and control. The students will study various network functions such as error-recovery algorithms, flow control, congestion control, routing, multi-access, switching, etc. They will also study these in the context of current Internet solutions (e.g. TCP, IP, etc.) and future open problems and possible solutions.

Recommended Book:

1. Hercog, Drago. "Communication Protocol Performance." Communication Protocols. Springer, Cham, 2020. 83-94.
2. Hercog, Drago. "Protocol Stack." Communication Protocols. Springer, Cham, 2020. 67-81.

S. No.	Course Code	Title of the course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	CS902	Data Warehouse & Mining	CLO.1: Understand the functionality of the various data mining and data warehousing components.										M		
			CLO.2: Appreciate the strengths and limitations of various data mining and data warehousing models					L							
			CLO.3: To acquire knowledge about data preprocessing, quality, manage, manipulate, clean and analyse data.		M										
			CLO.4: To acquire knowledge about modeling and design of data warehouses.	M											
			CLO.5: To implement various data clustering and classification approaches.		L										
2	CS924	Digital Image Processing	CLO.1: Understand fundamental steps of digital image processing.	M											
			CLO.2: Examine various types of images, intensity transformations and spatial filtering.					M							
			CLO.3: Understand, implement and compare various image enhancement techniques.								L				
			CLO.4: Implement and compare various image compression								M				

#	Code	Course	CLO														
			techniques.														
			CLO.5: Apply image processing algorithms in practical applications.		H												
3	CS925	Digital Image Processing Lab	CLO.1: Understand the installation of software		H												
			CLO.2: Practice the codes on software to gain better knowledge		H												
4	CS921	Advanced Computer Networks	CLO.1: Understand the main abstract concepts related to the layered communication architecture.	M													
			CLO.2: Analyze and implement some of the most advanced routing and congestion control algorithms. Evaluate the performances of computer networks (through mathematical modeling and simulation).							M							
			CLO.3: Understand basics and principles of new generation of computer networking infrastructure (VoIP, SIP, RTP).	M														
			CLO.4: Practice Networking Simulating skills as employed in Industry for Planning and Design (CISCO Packet Tracer).		H													
5	CS922	Advanced Computer	CLO.1: understand the captured data by using the relevant tools and focus											H			

#	Code	Course	CLO	1	2	3	4	5	6	7	8	9	10	11
		Networks Lab	on the involvement of layered approach in data transmission.											
			CLO.2: enhance the analytical skills of the students to understand and simulate the working of TCP/IP reference model.							M				
6	RS991	Intellectual Property Rights and Publishing Research (I)	CLO.1: Understand the Basics and Need of IPRs.	H										
			CLO.2: Fill the invention disclosure form for patenting of an idea.						M					
			CLO.3: Conduct the prior art to decide the patentability of the idea.							H				
			CLO.4: Draft provisional/complete specifications of the patent application.							H				
			CLO.5: Understand the challenges of the country in cause of promoting high quality research.	M										
			CLO.6: Better appreciate the meaning of some basic terminologies related to general parameters used for gauging the research outcome.	H										
			CLO.7: Use the Nature Master Class solution to their advantage, which will further help them in writing better quality research papers.					M						

#	Code	Course	CLO												
7	RS992	Intellectual Property Rights and Publishing Research (II)	CLO.1: appreciate the need of involving himself in cause of research.				H								
			CLO.2: understand different aspects involved in a research article which make that a great paper.				M								
			CLO.3: prepare a good summary of the literature survey carried out before starting to write a research paper himself.							M					
			CLO.4: full-fledged research paper which can submitted to flagship journals and conferences.			L									
8	CS908	Advanced DBMS	CLO.1: Understand the functionality of the various database systems.	M						L					
			CLO.2: Practice the codes and study about the case studies.											M	
			CLO.3: Implement procedures, functions, cursors and triggers and become proficient in PL/SQL programming skills	M						L					
9	CS909	Advanced DBMS Lab	CLO.1: Learn the installation of the software.		M	L									
			CLO.2: Design a commercial relational database system, skilled in Oracle, MySQL.		M									L	

S.No	Code	Course	CLO													
10	CS913	Advanced Operating Systems	CLO.1: Create Cloud using multiple operating systems simultaneously.					M								
			CLO.2: Detailed case study on Linux family.					M								H
			CLO.3: Live experiments on concurrency, threads and deadlocks.		H											
			CLO.4: To create your own operating system.			H				L						
11	CS903	Cryptography & Network Security	CLO.1: Identify common network security vulnerabilities/attacks.			L								M		
			CLO.2: Explain the foundations of Cryptography and network security.				L							M		
			CLO.3: Critically evaluate the risks and threats to networked computers.					M								
			CLO.4: Demonstrate detailed knowledge of the role of encryption to protect data. Analyze security issues arising from the use of certain types of technologies.						L							
			CLO.5: Identify the appropriate procedures required to secure networks.							M						
12	RS993	Research Methodology	CLO.1: Start a carrier in research.	H												
			CLO.2: Can decide about various tools and techniques which will help them in research for analysis, ethics,									M				

No.	Code	Course	CLO													
			presentation and writing of research.													
13	CS906	Advanced Data Structures	CLO.1: Learn the various data structures used.	H												
			CLO.2: Understand the data visualization.								H					
14	CS907	Advanced Data Structures Lab	CLO.1: Learn the installation of software.		H											
			CLO.2: Write loops, functions and pass arguments.				M									
15	CS910	Distributed Computing	CLO.1: After Completing this course, the students will be able to Analyze the data, identify the problems.				M									
			CLO.2: The students will able to choose the relevant models and algorithms to turn available data into valuable and useful information.		M						L					
			CLO.3: The students will able to apply different machine learning problems.	H												
			CLO.4: The students will be able to evaluate the performance of models.		M								L			
			CLO.5: Expose students to new techniques and ideas that can be used to improve the effectiveness of current BI tools.		M					L						

#	Code	Course	CLO													
16	CS911	Distributed Computing Lab	CLO.1: Implement and apply knowledge of parallel and distributed computing skills and methodologies.							M					
			CLO.2: Implement and design, development, and performance analysis of parallel and distributed applications.		M											
17	CS951	Programming in C#	CLO:1 Implement the concept of object-oriented techniques and methodologies using c#		M									L	
			CLO:2 Use Exception Handling concepts and skills for a Robust Application in c#.		M					L					
			CLO:3 Demonstrate an understanding of c# Input and Output							L					
			CLO:4 Develop applications using multithreading concept of c#.		M										
18	CS952	Programming in Python	CLO:1 Run basic python programs.	M								L			
			CLO:2 Use python skills in various fields of Data Science, Machine Learning and	M						L					
			CLO:3 Artificial Intelligence.							L					
			CLO:4 Logic building using looping and decision statements.	M			M								
			CLO:5 Develop problem solving abilities using Python.				M					L			
			CLO:6 Learn building packages and modules for reusability.									M			
19	CS954	Advanced Programming in Java	CLO.1 Design thewebsite.			M					L				
			CLO.2 Develop project using Spring framework skill.								M				

Sr.	Code	Course	CLO	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
			CLO.3 Maintain and enhance existing web platform.		M	M									
			CLO.4 Implement several Data structures using Collection Framework.			M						L			
			CLO.5 Use database connectivity for a complete Java application.									M			
20	CS955	Virtual Private Network	CLO:1 Use highly secure VPN communications, with access rights tailored to individual users			M									
			CLO:2 USe VPN products to add new sites or users, without significantly expanding your existing infrastructure	M										L	
			CLO:3 Extend skills of corporate networks, applications, and collaboration tools by using VPN	M						L					
			CLO:4 Reduce communications costs while increasing flexibility							M					
21	CS956	Biometric Security	CLO:1 Apply biometric matching for identification	M											
			CLO:2 Identify algorithms for finger biometric technology	M										L	
			CLO:3 Apply skills of facial biometrics for identification.	M						L					
			CLO:4 Apply iris biometric, voice biometric, physiological biometrics etc. for identification.							M					
22	CS957	Software Testing and Quality Assurance	CLO:1 Understand software testing and quality assurance as a fundamental component of software life cycle	M	M									L	
			CLO:2 Infer various software models concepts and skills for making the software.		M				L						

No	Code	Course	CLO														
			CLO:3 Analyse software creating requirements to determine the entities involved in the system and their relationship to one another.										M				
			CLO:4 To make sure that the result meets the business and user requirements Software testing plays an instrumental role.		M												
			CLO:5 Also, to satisfies the BRS that is Business Requirement Specification and SRS		M											L
23	CS958	S/WProject Management	CLO:1 To acquire presentation and communication skills		M								L			
			CLO:2 Undertake problem identification, formulation and solution to make students employable.										M			
			CLO:3 Design engineering solutions to complex problems utilizing a systems approach		M											
			CLO:4 To implement learning in real life problem for skill development	M										L		
			CLO:5 To propose multiple solution to any given problem and find best out of those.	M							L					
24	CS959	Cloud Computing and Virtualization	CLO.1 Students will be able to identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.									M				
			CLO.2 Students will be able to explain the core issues of cloud computing such as security, privacy,	M												

#	Code	Course	CLO	1	2	3	4	5	6	7	8	9	10
			and interoperability.										
			CLO.3 Students will be able to identify problems, and explain, analyze, and evaluate various cloud computing solutions.	M								L	
			CLO.4 Students will be able to provide the appropriate cloud computing solutions and recommendations according to the applications used.	M					L				
			CLO.5 Students will be able to build skills to generate new ideas and innovations in cloud computing.	M								L	
25	CS960	Natural Language Processing	CLO:1 Learning the basic concepts and skills of Artificial Intelligence.	M					L				
			CLO:2 Represent Knowledge using propositional calculus and predicate calculus.						M				
			CLO:3 Use inference rules to produce predicate calculus expression.	M	M								L
			CLO:4 Demonstrate awareness of informed search and uninformed search techniques.		M					L			
			CLO:5 Explain about AI techniques for planning, knowledge representation and management.							M			
			CLO:6 Outline the process involved in Expert systems and in building such systems.		M								
26	CS961	Pattern Recognition	CLO:1 Understand and gain skills of basic concepts in pattern recognition		M								L

No.	Code	Course	CLO	1	2	3	4	5	6	7	8	9	10	11	12	13
			CLO:2 Gain knowledge about state-of-the-art algorithms used in pattern recognition research		M						L					
			CLO:3 Understand pattern recognition theories, such as Bayes classifier, linear discriminant analysis.								M					
			CLO:4 Apply pattern recognition techniques in practical problems.		M											
27	CS953	Programming in R	CLO:1 Use R skills in various fields of Data Science, Machine Learning and Artificial Intelligence.				M									
			CLO:2 Logic building using looping and decision statements.				M									
			CLO:3 Develop problem solving abilities using R				M						L			
			CLO:4 Learn building packages and modules for reusability.										M			
			CLO:5 Learn GUI development using Widgets in R.			M										L
28	CS962	Next Generation Wireless and Sensor Networks	CLO:6 Implement skill based knowledge of routing mechanisms and the three classes of approaches: proactive, on-demand, and hybrid	M									L			
			CLO:7 Study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.	M						L						
			CLO:8 Identify the issues and challenges in providing QoS							M						
			CLO:9 Explain about the energy management in ad-hoc networks	M												
			CLO:10 Demonstrate various types of mesh networks.		M									L		
			CLO:11 Implement skill based knowledge of routing mechanisms and the three classes of approaches:		M						L					

#	Code	Course	CLO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
			proactive, on-demand, and hybrid																
29	CS963	Big Data Analytics	CLO:1 Understand and implement classical models and algorithms in machine learning as well as python programming concepts.											M					
			CLO:2 Analyze the data, identify the problems	M															
			CLO:3 Learn the skills to analyze relevant models and algorithms to turn available data into valuable and useful Information.	M														L	
			CLO:4 Understand the comparative study of the related approaches.	M										L					
			CLO:5 Explore new techniques and ideas that can be used to improve the effectiveness of current AI tools.											M					
			CLO:6 Understand and implement classical models and algorithms in machine learning as well as python programming concepts.	M															
30	CS964	Soft Computing	CLO:1 Learn about soft computing skills and techniques of their applications	M														L	
			CLO:2 Analyze various neural network architectures	M										L					
			CLO:3 Understand perceptrons and counter propagation networks.											M					
			CLO:4 Define the fuzzy systems	M															
			CLO:5 Analyze the genetic algorithms and their applications.	M	L														
31	CS9643	Communication Network and Protocols	CLO:1 Skilled to use and implement internet technology		M														
			CLO:2 To understand the functioning of Frame Relay, ATM. and security issues related to data communication in networks		M	L													