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.
Academic Year: 2016-17

Approved by the 17th Academic Council vide agenda item 17.5 dated 27-06-2016

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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. To provide the solution for the complex engineering problems by using the concepts of Computer Science and Engineering.

PEO 2. To work independently and efficiently in multi-disciplinary teams by communicating effectively.

PEO 3. To acquire the additional knowledge and skills through enduring edification.

PEO 4. To contribute effectively towards sustainable solution for environment and society.

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.

To contribute in building skillful society.

Mapping of PEO with PO:

	PEO1	PEO2	PEO3	PEO4
PO1	M			
PO2				H
PO3		H		
PO4		H		
PO5				M
PO6	L		H	
PO7			M	
PO8		M		
PO9	M			
PO10	L			H
PO11	M	M		M
PO12		H		H

Mapping of PEO with Mission:

	PEO1	PEO2	PEO3	PEO4
M1	H	M		
M2	H	H		
M3			H	
M4			M	H

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. Eligibility for Admission

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 the written test followed by an interview.

3. Programme Duration

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. **Pedagogical Aspects**

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 55 minutes.

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. **Programme Structure**
Model Programme Structure

		Semester-1		
S.No	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1	CSL4631	Distributed Computing	4-0-0	4
2	CSP1631	Distributed Computing Lab	0-0-2	1
3	CSL4632	Advanced Data Structure	4-0-0	4
4	CSP1632	Advanced Data Structures Lab	0-0-2	1
5	CSL4633	Information Security	4-0-0	4
			16	**14**

		Semester-2		
S.No	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1	ECL 4606	Digital Image Processing	4-0-0	4
2	ECP 1606	Digital Image Processing Lab	0-0-2	1
3	CSL 4502	Advanced Computer Networks	4-0-0	4
4	CSP 1502	Advanced Computer Networks Lab	0-0-2	1
5		Elective I	4-0-0	4
			16	**14**

		Semester-3		
S.No	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1	CSL4635	Advanced Database Management Systems	4-0-0	4
2	CSP1635	Advanced Database Management Systems Lab	0-0-2	1
3	CSL4636	Advanced Software Engineering	4-0-0	4
4		Elective II	4-0-0	4
			14	**13**

		Semester-4		
S.No.	**Course Code**	**Course Title**	**L-T-P**	**Credits**

1	CSL4211	Advanced Algorithms	4 0 0	4
2	CSL 4212	Data Mining and Machine Learning	4 0 0	4
3	ECL 2601	Publishing Research	2 0 0	2
4		Elective III	4 0 0	4
			14	**14**

Semester-5				
S.No	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1	PRM4101	Research Methodology	4-0-0	4
2	CSL2518	IPR	2-0-0	2
			6	**6**

Semester-6				
S.No	**Course Code**	**Course Title**	**L-T-P**	**Credits**
1	CST9702	Thesis	---	20
			---	**20**

Total Credits = 81

List of Electives

Elective I

Course Code	Course Title	Credits
CSL4625	Programming in C#	4
CSL4626	Programming in Python	4
CSL4661	Programming in R	4

Elective II

Course Code	Course Title	Credits
CSL4671	Software Testing and Quality Assurance	4
ECL4602	Next Generation Wireless and Sensor Networks	4
CSL4662	Cloud Computing and Virtualization	4
CSL4663	Natural Language Processing	4
CSL4651	Engineering Education	4
CSL4641	Big Data Technology	4

Elective III

Course Code	Course Title	Credits
CSL4664	Requirement Elicitation	4
CSL4665	Software Project Management	4
CSL4666	Modelling and Simulation	4
CSL4667	Network Programming	4

CSL4668	Virtual private Network	4
CSL4669	Biometric Security	4
ECL4627	System Implementation of Vision	4
CSL4652	Speech Signal Processing	4
CSL4653	Pattern Recognition	4
ICP4306	Mobile Application Development	4
CSL4670	Soft Computing	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 Head of the Department. 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 Head of the Department 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 Head of the Department 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

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
	I	0	Incomplete / 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-	6	3 x 6	18
Course X	3	A-	8	3 x 8	24
Course Y	3	A+	10	3 x 10	30
Course Z	2	A+	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

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

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 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 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 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 14 are core courses and 3 are elective courses and 4 are research/industry-oriented subjects. 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 Outline

Course Code	Course Name	L-T-P	Credits
CSL4631	Distributed Computing	4-0-0	4

Course Learning Outcomes:

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:

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

Course Code	Course Name	L-T-P	Credits
CSP1631	Distributed Computing Lab	0-0-2	1

Course Learning Outcomes:

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.

S. No.	Experiment Detail
1-2	Implement concurrent echo client-server application o Implement Client program o Implement Server program
3-4	Implementation of Chat application using socket programming in Java o Implement Chat Client o Implement Chat Server
5-6	Create RMI based server-client application o Implement remote interface o Implement the remote object by implementing the remote interface. o Implement the client program.
7-8	Create RMI based server-client based Calculator application o Implement remote interface o Implement the remote object by implementing the remote interface. o Implement the client program.
9-10	Create CORBA based server-client application o Implement remote interface o Implement the remote object by implementing the remote interface. o Implement the client program.

Recommended Books:

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

Course Code	Course Name	L-T-P	Credits
CSL4632	Advanced Data Structure	4-0-0	4

Course Learning Outcomes:

Students will be able to:

CLO.1:   Gain skills to analyze algorithms and algorithm correctness.
CLO.2:   Analyze time complexities of algorithms using asymptotic analysis.

CLO.3:   Summarize searching and sorting techniques.

CLO.4:   Describe stack, queue and linked list operation. And can compare between different data structures. Pick an appropriate data structure for a design situation.

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.

Recommended Books:

- Seymour Lipschutz," Data Structures", Published By Tata McGraw-Hill, Second Edition.
- Hubbard, Anita Huray, "Data Structures with Java, R", Prentice Hall of India, Second Edition,
- Richard Gilberg, Behrouz Forouzan,"Data Structures", McGraw-Hill, Second edition
- Narasimha Karumanchi,"Data Structures and Algorithms Made Easy: Data Structure and Algorithmic Puzzles", Pearson publication, Third Editon.

Course Code	Course Name	L-T-P	Credits
CSP1632	Advanced Data Structure Lab	0-0-2	1

Course Learning Outcomes:

Students will be able to:

CLO.1:	Implement skills to analyze algorithms and algorithm correctness.
CLO.2:	Implement and analyze time complexities of algorithms using asymptotic analysis.

Practical No.	Practical Name
1.	Array
	1.1 Array Traversing 1.2 Array Insertion 1.3 Array Deletion
2.	Linked List Implementation
	Creation, Insertion, Deletion and Traversal
3.	Stack
	3.1 Insertion and Deletion in stack using array 3.2 Insertion and Deletion in stack using linked list
4.	Queue
	4.1 Insertion and Deletion in queue using array 4.2 Insertion and Deletion in queue using linked list
5.	Polish Notations
	5.1 Infix to postfix 5.2 Infix to prefix 5.3 Evaluation of postfix
6.	Sorting and Searching in an Array
	6.1 Insertion Sort 6.2 Selection Sort 6.3 Linear Search 6.4 Binary Search
7.	Multiple Stack Implementation
8.	Multiple Queue Implementation
9.	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.
10.	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.

Recommended Books:

- Seymour Lipschutz," Data Structures", Published By Tata McGraw-Hill, Second Edition.
- Hubbard, Anita Huray, "Data Structures with Java, R", Prentice Hall of India, Second Edition,
- Richard Gilberg, Behrouz Forouzan,"Data Structures", McGraw-Hill, Second edition
- Narasimha Karumanchi,"Data Structures and Algorithms Made Easy: Data Structure and Algorithmic Puzzles", Pearson publication, Third Editon.

Course Code	Course Name	L-T-P	Credits
CSL4633	Information Security	4-0-0	4

Course Learning Outcomes:

Students will be able to:

CLO.1:   Review and practice computer and network etiquette and ethics found in working environments

CLO.2:   Perform risk assessment

CLO.3:   Install, configure, use and manage anti malware software on a working network

CLO.4:   Evaluate best practices in security concepts and skills to maintain confidentiality, integrity and availability of computer systems

CLO.5:   Articulate informed opinion about issues related to cyber security

Course Outline:-

Information Security: Introduction, What is Security, CNSS Security Model, Components of Information System, Balancing Information Security and Access, Approaches to Information Security Implementation, Balancing Security and Access, The

SDLC, The Security of SDLC, Security professionals and the organizations

Need for Security: Business Needs, Threats, Attacks, Principles of secure software development, problem areas of software development.

Legal, Ethical and Professional Issues in Information Security: Laws and Ethics in Information Security, International Laws and Legal Bodies, Ethics and Information Security, Codes of Ethics and Professional Organizations

Risk Management: An Overview of Risk Management, Risk Identification, Risk Assessment, Risk Control Strategies, Selecting a Risk Control Strategy, Quantitative Versus Qualitative Risk Control Practices

Policy and Practices: Blueprint for Security, Information Security Policy, Standards and Practices, NIST Models, Continuity Strategies.

Security Technology: Access Control, Firewalls, Intrusion detection and prevention systems,   Scanning   and   Analysis   Tools.

Cryptography: Concepts and Techniques, symmetric and asymmetric key cryptography, steganography, Classical Encryption Techniques – Symmetric and Asymmetric cryptography

Public-Key Infrastructure, Digital Signatures, Digital Certificates, Hybrid Cryptography System.

Recommended Book(s):

- Thomas R Peltier, Justin Peltier and John blackley, "Information Security Fundamentals", 2nd Edition, Prentice Hall, 1996
- Michael E. Whitman, Herbert J. Mattord, Principles of Information Security:, CENGAGE Learning, 4th Edition.
- Micki Krause, Harold F. Tipton, "Handbook of Information Security Management", CRC Press LLC, 2004.
- William Stallings, Cryptography and Network Security, Pearson Education,4th Edition

Course Code	Course Name	L-T-P	Credits
ECL4606	Digital Image Processing	4-0-0	4

Course Learning Outcomes:

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:   Skill to understand and compare various image enhancement techniques
CLO.4:   Skill to understand and implement basic image segmentation techniques

Course Outline:-

Fundamentals of Image Processing: Fundamental steps in Digital Image Processing, Components of digital image processing system, elements of visual perception, Structure of the human eye, Image formation in the eye, Simple image formation model, Image Sampling and Quantization, Basic relationship between pixels, Linear and Non-Linear operations.

Image Enhancement in the spatial domain: Gray level transformations, Piecewise linear transformation, Histogram processing, enhancement using Arithmetic/ logic operations, Basics of spatial filtering, Smoothing and sharpening spatial filters, Use of first order and second order derivative in enhancement.

Image Enhancement in the frequency domain: Two dimensional Fourier transform, properties of frequency domain, correspondence between filtering in spatial and frequency domain, Smoothing and Sharpening frequency domain filters, Homomorphic filtering

Morphological Image Processing: Basic Morphological Operations, Dilation, erosion, Opening & Closing, Some basic morphological algorithms :- Boundary Extraction, Region Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeltons, Pruning

Image Segmentation: - Detection of discontinuities (point, line edge), Edge linking and boundary detection, Thresholding, Basic global thresholding, Adaptive thresholding, Region based segmentation, region growing, splitting and merging.

Image Restoration: A Model of Image Degradation / restoration process. Different noise models, Restoration in the presence of noise only-spatial filtering, Periodic noise reduction by frequency domain filtering, Inverse filtering, Minimum Mean Square Error (Wiener) Filtering.

Recommended Book(s):

- Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing", Pearson Education, Third Editon
- W.K. Pratt, "Digital Image Processing , "McGraw Hill, Second Editon
- R.C. Gonzalez and R. E. Woods, "Digital Image Processing",:Addison Wesley/ Pearson Education, Second Editon
- Gonzalez, "Digital Image Processing", Pearson International Edition, Third Editon

Course Code	Course Name	L-T-P	Credits
ECP1606	Digital Image Processing Lab	0-0-2	1

Course Learning Outcomes:

Students will be able to:

CLO.1: Implement fundamental steps of digital image processing

CLO.2: Implement various skills for types of images, intensity transformations and spatial filtering.

S. No.	Experiment Detail
1	To study fundamentals of image processing and write program to read and display different types of digital images.
2	To perform basic geometric transformations (2-D DFT, FFT etc.) on Digital Images.
3	To write program for zooming and shrinking of digital images and compare Nearest Neighbor interpolation, Bilinear interpolation and Bicubic interpolation methods of zooming.
4	To Perform enhancement in spatial domain on digital images and write programs for gray-level transformations, histogram processing and image averaging and subtraction.
5	To Perform Spatial domain Enhancement using Filtration of digital images.
6	To Perform Frequency domain Enhancement using Filtration of digital images.
7	To study and perform Image Restoration using Wiener Filters.
8	To perform Color Image Processing: Finding color negatives, histograms, smoothing and sharpening of color images.
9	(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
10	To perform detection of discontinuities: point, line and edges in a given image and study image Segmentation.

Recommended Book(s):

● Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing", Pearson Education, Third Editon
● W.K. Pratt, "Digital Image Processing , "McGraw Hill, Second Editon
● R.C. Gonzalez and R. E. Woods, "Digital Image Processing",:Addison Wesley/ Pearson Education, Second Editon
● Gonzalez, "Digital Image Processing", Pearson International Edition, Third Editon

- Silberscatz, Korth, Sudarshan, "Database System Concepts", Mcgraw Hill, 6[th]Edition, 2006
- D. Maier, "The Theory of Relational Databases", 1993, Computer Science Press, Rokville, Maryland

Course Code	Course Name	L-T-P	Credits
CSL4502	Advanced Computer Networks	4-0-0	4

Course Learning Outcomes:

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).
Encryption (secret and public keys), Kerberos, PGP, SSH, SSL. Network Management,

SNMP, Session Initiation Protocol (SIP), VoIP.

Recommended Book(s):

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

Course Code	Course Name	L-T-P	Credits
CSP1502	Advanced Computer Networks Lab	0-0-2	1

Course Learning Outcomes:

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.

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

2. To design and perform IP addressing in network.

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

4. To design and implement a computer network demonstrating Star Topology.

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

6. To design and simulate Static Routing.

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

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

9. To design and simulate EIGRP Routing.

10. To create and implement ACL: Standard and Extended.

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

12. Simulate the transmission of ping messages over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion.

13. Simulate a three node point to point network with duplex links between them. Set queue size and vary the bandwidth and find number of packets dropped using NS2.

Recommended Book(s):

- CCNA Study Guide by Sybex Publication
- CCNA Preparation Guide by Cisco Press

Elective I

Course Code	Course Name	L-T-P	Credits
CSL4625	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 and Characteristics 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 Write Line 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 ,Array List 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 Sample WinApp Windows Application, Creating and Running a SampleWinApp2 Windows Application, Web-based Application on .NET

Recommended Books:
- Jesse Liberty, "Programming C#", Second Edition, O'Reilly Press, 2002.

- Svetlin Nakov & Co., "Fundamentals of Computer Programming With C# ", 2013.

Course Code	Course Name	L-T-P	Credits
CSL4626	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.

Recommended Books

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

Course Code	Course Name	L-T-P	Credits
CSL4661	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.

DPLYR PACKAGE: Load data into dataframe, Viewing the data, Selecting columns Selecting rows, Reordering the rows, Pipe operator, Group operations

Recommended Books:

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

Course Code	Course Name	L-T-P	Credits
CSL4635	Advanced Database Management Systems	4-0-0	4

Course Learning Outcomes:

Students will be able to:

CLO.1: Understand and gain skills functionality of the various database systems.
CLO.2: Practice the codes and study about the case studies.

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

T/O based techniques, Multiversion approaches, Comparison of CC methods, dynamic databases, Failure classification, recovery algorithm, XML and relational databases

Recommended Book(s):

- Elmarsi, Navathe, Somayajulu, Gupta, "Fundamentals of Database Systems", 4thEdition, Pearson Education, 2007
- Garcia, Ullman, Widom, "Database Systems, The complete book", Pearson Education, 2007
- R. Ramakrishnan, "Database Management Systems", McGraw Hill International

Editions, 1998
- Date, Kannan, Swaminathan, "An Introduction to Database Systems", 8[th]Edition Pearson Education, 2007
- Singh S.K., "Database System Concepts, design and application", Pearson Education, 2006.
- Silberscatz, Korth, Sudarshan, "Database System Concepts", Mcgraw Hill, 6[th]Edition, 2006
- D. Maier, "The Theory of Relational Databases", 1993, Computer Science Press, Rokville, Maryland
- Ullman, J. D., "Principals of database systems", Galgotia publications, 1999
- Oracle Xi Reference Manual

Course Code	Course Name	L-T-P	Credits
CSP1635	Advanced Database Management Systems Lab	0-0-2	1

Course Learning Outcomes:

Students will be able to:

CLO.1:   Learn the installation of the software.
CLO.2:   Practice the codes to gain better skills of knowledge.

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.

Inventory Control System.

Material Requirement Processing.

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

Course Code	Course Name	L-T-P	Credits
CSL4636	Advanced Software Engineering	4-0-0	4

Course Learning Outcomes:

Students will be able to:

CLO.1: Acquire strong fundamental knowledge in science, mathematics, fundamentals of computer science, software engineering and multidisciplinary engineering to begin in practice as a software engineer.

CLO.2: Design applicable solutions in one or more application domains using software engineering approaches that integrate ethical, social, legal and economic concerns.

CLO.3: Deliver quality software products by possessing the leadership skills as an individual or contributing to the team development and demonstrating effective and modern working strategies by applying both communication and negotiation management skill.

CLO.4: Apply new software models, techniques and technologies to bring out innovative and novelistic solutions for the growth of the society in all aspects and evolving into their continuous professional development.

Course Outline:-
Introduction to Software Engineering: The Evolving Role of Software, Changing nature of

software

Getting the basics of Agile: Looking Back at Software Development Approaches, Code-and-Fix/Big Bang development, Waterfall, The Spiral model, Introducing the Agile Manifesto, the 12 principles that drive the Agile Manifesto, Redefining Today's Agile

An Agile View of Process: what is agility, what is an agile process, agile process models: extreme programming(XP), ASD, Scrum

Requirements Engineering: Requirements Engineering Tasks: Initiating Requirement, engineering Process, Eliciting Requirements

Building Analysis Model: Requirement Analysis, Data modeling Concepts, Flow Oriented Modelling,

Risk Management: Software Risks & Risk Strategies, Risk Identification, Risk Projection, Risk Mitigation, Monitoring and Management (RMMM) plan, Overview of Quality Management, Quality Management, Change Management

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

Software Testing Strategies and Tactics: A strategic approach for Software Testing, Software Testing Strategies: Unit Testing, Integration Testing, Validation Testing, System Testing, White-Box Testing Techniques: Basis Path Testing, Control Structure Testing, Black -Box Testing Techniques: Equivalence Partitioning and Boundary Value Analysis.

Computer-Aided Software Engineering • Introduction • Building Blocks for CASE • Taxonomy of CASE Tools • Integrated CASE Environments • Integration Architecture • CASE Repository • Case Study of Tools like TCS Robot.

Recommended Book(s):

- Roger S. Pressman," Software Engineering, A practitioner's Approach", McGraw-Hill International Edition, Sixth Editon
- Ian Sommerville," Software Engineering", Adison- Wesley Pub. Co, Sixth Editon
- Pankaj Jalota," An Integrated Approach to Software Engineering", Narosa Publishing, Third Edition
- Bernd Bruegge and Allen H. Dutoit," Object-Oriented Software Engineering", Pearson, Third Edition

Elective II

Course Code	Course Name	L-T-P	Credits
CSL4671	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 System Requirement Specifications and finally gain the confidence of the customers by providing them a quality product.

Course Outline:-

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

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

Course Code	Course Name	L-T-P	Credits
ECL4602	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):

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

Course Code	Course Name	L-T-P	Credits
CSL4662	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
- Architecting the Cloud by Michael J. Kavis
- Cloud Computing Bible by Barrie Sosinsky
- Cloud Computing- The Complete Cornerstone Guide to Cloud Computing Best practices.

Course Code	Course Name	L-T-P	Credits
CSL4663	Natural Language Processing	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Learning 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.

Semantic Analysis - Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labeling and Semantic Parsing.

Information   Extraction   (IE)
- Named entity recognition and relation extraction. IE using sequence labeling.

Machine Translation (MT) - Basic issues in MT. Statistical translation, word alignment, phrase-based translation, and synchronous grammars.

Recommended Books
- "Speech and Language Processing": Jurafsky and Martin, Prentice Hall
- "Statistical Natural Language Processing"- Manning and Schutze, MIT Press
- "Natural Language Understanding". James Allen. The Benajmins/Cummings Publishing Company Cover, T. M. and J. A. Thomas: Elements of Information Theory. Wiley.
- Charniak, E.: Statistical Language Learning. The MIT Press.
- 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
CSL4651	Engineering Education	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Attain a position solving real-world problems using mechanical engineering skills and principles developed while studying at Seattle University;

CLO.2 Participate in ongoing personal and professional growth by actively seeking additional skills and experiences, for example engaging in continuing education and/or pursuing advanced degrees;

CLO.3 Contribute to society through involvement in professional organizations, developing mentorship relationships, taking on leadership roles, and other service activities.

Course Outline:-

Engineering Education – concept, significance in Indian context, scope of Engineering Education and Role of Engineer and Technicians, Educating the engineers of new century - Generic Skills appropriate to engineering practices: speaking, listening, reading, writing, decision making, problem solving, team building, creativity, and adaptability: their concepts, importance and strategies for enhancing these skills), Educational Technology : Concept, Types of Educational Technology- Technology in Education, Technology of Education and Systems Approach to Educational Technology, Planning and Organizing for Instruction in engineering contexts : Steps in Instructional Planning – Understanding learners; task analysis; writing instructional objectives; instructional methods (Problem Based Learning, Case Study and Cooperative Learning); selecting evaluation techniques; Developing lesson plans (Theory and Practical); Development of instructional resources (handouts, instructional sheets, tutorial sheets, exercises, PowerPoint), Implementing Instruction: Motivating students Concept, types and techniques, Ensuring student - involvement through Integration of media (internet and computer), Evaluation of learning outcomes and teacher effectiveness: Concept, dimensions, Evaluating learning outcomes (cognitive, psychomotor & affective) , Teacher effectiveness (self, peer and superior evaluation).

Suggested Book(s):

- Bhattacharya, SK (2006) Educational Technology. New Delhi: Abhishek Publications 2006
- Cole PG and Chan LKG (1987) Teaching Principles & Practice New York: Prentice Hall
- Duffy Judy Lever, McDonald Jean (2010) Teaching and Learning with Technology.
- Gagne, RM & Briggs LJ (1980) Principles of instructional design. New York: Holt, Rinohart & Winston.Inc.
- Kulkarni, SS (1986) Introduction to Educational Technology. New Delhi: Oxford & IBH Publishing company

Course Code	Course Name	L-T-P	Credits

| CSL4641 | Big Data Technology | 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 Map Reduce programming model. Installation and running a program using Hadoop.

Introduction to Pig: Overview, Architecture, Installation, Execution, Grunt Shell; Pig Latin basics; Reading Data, Storing data, Diagnostic Operators, Describe Operator, Group operator, Co-group operator, Join operator, Cross operator, union operator, split operator, Distinct operator, foreach operator, order by, limit operator;

Recommended Books

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

Course Code	Course Name	L-T-P	Credits
CSL4211	Advanced Algorithms	4-0-0	4

Course Learning Outcomes:

Students will be able to:

CLO.1 Analyze algorithms and algorithm correctness.

CLO.2 Analyze time complexities of algorithms using asymptotic analysis.

CLO.3 Summarize searching and sorting techniques.

CLO.4 Describe stack, queue and linked list operation. Compare different data structures and pick an appropriate data structure for a design situation.

CLO.5 Explain the major graph and tree algorithms and their analysis skills. Employ graphs to model engineering problems.

Course Outline:-

Analysis of Algorithm: The efficient algorithm, Average, Best and worst case analysis, Amortized analysis, Asymptotic Notations, Analyzing control statement, Loop invariant and the correctness of the algorithm, Sorting Algorithms and analysis: Shell sort, Heap sort, Sorting in linear time: Bucket sort, Radix sort and Counting sort

Dynamic Programming

Introduction, The Principle of Optimality, Problem Solving using Dynamic Programming – Calculating the Binomial Coefficient, Making Change Problem, Assembly Line-Scheduling, Knapsack problem, Shortest path, Matrix chain multiplication, Longest Common Subsequence.

Backtracking and Branch and Bound: Introduction, The Eight queen problem, Knapsack problem, Travelling Salesman problem, Minimax principle

Introduction to NP-Completeness: The class P and NP, Polynomial reduction, NP-Completeness Problem, NP-Hard Problems. Travelling Salesman problem, Hamiltonian problem, Approximation algorithms

Randomized Algorithms: Introduction, Type of Randomized Algorithms, Min- Cut, 2-SAT;Game Theoretic Techniques, Random Walks.

Recommended Books:

- Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, PHI.
- Fundamental of Algorithms by Gills Brassard, Paul Bratley, PHI.
- Introduction to Design and Analysis of Algorithms, AnanyLevitin, Pearson.
- Foundations of Algorithms, Shailesh R Sathe, Penram
- Design and Analysis of Algorithms, Dave and Dave, Pearson.

Course Code	Course Name	L-T-P	Credits
CSL4212	Data mining & Machine learning	4-0-0	4

Course Learning Outcomes:

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:-

What is Data Mining? Motivating Challenges; The origins of data mining; Data Mining Tasks. Types of Data; Data Quality. Data Preprocessing; Measures of Similarity and Dissimilarity, Machine learning, Hypothesis, Version space, MAP, Maximum likelihood.

Classification: Preliminaries; General approach to solving a classification problem; Decision tree induction; Rule-based classifier; Nearest-neighbor classifier, SVM, Artificial Neural Networks. Association Analysis: Problem Definition; Frequent Itemset generation; Rule Generation; Compact representation of frequent itemsets; Alternative methods for generating frequent item-sets, Neural Networks. Evaluation parameters, accuracy, validation, ROC, types of error.

Cluster Analysis: Overview, K-means, Agglomerative hierarchical clustering, DBSCAN, Overview of Cluster Evaluation, Further Topics in Data Mining: Multidimensional analysis and descriptive mining of complex data objects;

Spatial data mining; Multimedia data mining; Text mining; Mining the WWW. Outlier analysis, data mining applications; Additional themes on Data mining; Social impact of Data mining; Trends in Data mining.

Data warehouse – Difference between Operational DBs and Data warehouses – Multidimensional Data Model – Data warehouse Architecture – Data warehouse Implementation – OLAP Techniques Concepts & Disadvantages, Data Mining, Introduction Data Mining – Knowledge Discovery from Databases(KDD) Process – Data Processing for Data Mining – Data Cleaning, Integration, Transformation, Reduction – Data Mining Primitives – Data Mining Query Language.

Recommended Books

- Data Mining: Concepts and Techniques (The Morgan Kaufmann Series in Data Management Systems) -- by Jiawei Han, Micheline Kamber.
- Insight into Data Mining – Theory and Practice - K.P.Soman, Shyam Diwakar, V.Ajay, PHI, 2006.

Course Code	Course Name	L-T-P	Credits
ECL2601	Publishing Research	2-0-0	2

Course Learning Outcomes:

Students will be able to:

CLO.1 Understanding of ethical issues related to Research and Publication.
CLO.2 Gain skills to write research papers/thesis following publication ethics. Related issues.
CLO.3 Gain skills to Publish ethically.
CLO.4 Gain skills to for avoiding plagiarism.

Course Outline:-

Introduction to Academic Writing, Structure of Academic Articles, Types of Academic Articles, choosing where to publish, Finding, keeping and disseminating information, submitting a manuscript, Delays in the publishing process, Refereeing, six differences in academic writing, how to conduct revision, Procrastination and writer's block, Plagiarism and How to prevent it, how to write letters to Editors.

Recommended Book(s):

- Viktor Wang, Handbook of Research on Learning Outcomes and Opportunities in the Digital Age (2 Volumes), December, 2015
- Medhi, J., Stochastic Processes, New Age International

Elective III

Course Code	Course Name	L-T-P	Credits
CSL4664	Requirement Elicitation	4-0-0	4

Course Learning Outcomes:

Students will be able to:

CLO.1 Establish a structure and process for gathering skill and information through interviews and group sessions

CLO.2 Conduct a successful skilful information gathering session

CLO.3 Identify and deal with interview and meeting problems

CLO.4 Catch and clarify assumptions and misinformation

CLO.5 Facilitate and mediate among the participants

The essential software requirement: Software requirements defined, Some interpretations of requirement", Levels and types of requirements, Working with the three levels, Product vs. project requirements, Requirements development and management, Requirements development, Requirements management, When bad requirements happen to good people, Insufficient user involvement, Inaccurate planning, Creeping user requirements, Ambiguous requirements, Gold plating, Overlooked stakeholders, Benefits from a high-quality requirements process

A requirements development process framework: Requirements elicitation, Requirements analysis, Requirements specification, Requirements validation, Requirements management, Knowledge & Project management, getting started with new practices

Establishing the business requirements: Defining business requirements, Identifying desired business benefits, Product vision and project scope, Conflicting business requirements, Vision and scope document, Business requirements, Scope and limitations, Business context, Scope representation techniques, Context diagram, Ecosystem map, Feature tree, Event list, Keeping the scope in focus, Using business objectives to make scoping decisions, Assessing the impact of scope changes, Vision and scope on agile projects, Using business objectives to determine completion

Requirements elicitation: Requirements elicitation techniques, Interviews, Workshops, Focus groups, Observations, Questionnaires, System interface analysis, User interface analysis, Document analysis, Planning elicitation on your project, Preparing for elicitation

Writing excellent requirements: Characteristics of excellent requirements, Characteristics of requirement statements, Characteristics of requirements collections, Guidelines for writing requirements, System or user perspective, writing style, Level of detail, Representation techniques, avoiding ambiguity, Avoiding incompleteness

Modelling the requirements: From voice of the customer to analysis models, Selecting the right representations, Data flow diagram, Swimlane diagram, State-transition diagram and state table, Dialog map, Decision tables and decision trees, Event-response tables, A few words about UML diagrams, Modelling on agile projects, Scenario, User Considerations, Involving Clients, Use Cases, Wireframes, Storyboards, Product Backlog, Story Maps.

Recommended Books

- Software Requirements by Karl Wiegers and Joy Beatty, Third Edition, Microsoft Press

Course Code	Course Name	L-T-P	Credits
CSL4665	Software 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.

STAFFING IN SOFTWARE PROJECTS -

Managing people – Organizational behavior – Best methods of staff selection – Motivation – The Oldham – Hackman job characteristic model – Stress – Health and Safety – Ethical and Professional concerns – Working in teams – Decision making – Organizational structures – Dispersed and Virtual teams – Communications genres – Communication plans – Leadership.

Recommended Books:
- Applied Software Project Management, Andrew Stellman and Jennifer Greene, O'Reilly Media

Course Code	Course Name	L-T-P	Credits
CSL4666	Modelling and Simulation	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Understand the techniques of modelling in the context of hierarchy of
CLO.2 Gain skill and knowledge about a system and develop the capability to apply the same to study systems through available software.
CLO.3 Students will learn different types of simulation techniques.
CLO.4 Students will learn to simulate the models for the purpose of optimum control by using software.

Course Outline:-

Introduction to Modelling and Simulation. Application areas, definition and types of system, model and simulation, introduction to discrete-event and continuous simulation.
Simulation Basics - Handling Stepped and Event-based Time in Simulations, Discrete versus Continuous Modelling, Numerical Techniques, Sources and Propagation of Error
Simulation Methods: Discrete-event Simulation, Time advance Mechanisms, Components and organization of Discrete event simulation, Flowchart of next-event time advance approach, Continuous Simulation, Random Number generation methods.
Queuing Models: Single server queuing system, introduction to arrival and departure time, flowcharts for arrival and departure routine. Event graphs of queuing model. Determining the events and variables.
Distribution Functions Stochastic activities, Discrete probability functions, Cumulative

distribution function, Continuous probability functions. Generation of random numbers following binomial distribution, poisson distribution, continuous distribution, normal distribution, exponential distribution, uniform distribution.

Programming in MATLAB: Introduction, Branching statements, loops, functions, additional data types, plots, arrays, inputs/outputs etc.

Programming in GPSS and C/C++: Basic Introduction to Special Simulation Languages:- GPSS and Implementation of Queuing Models using C/C++.

Introduction to Simulators: Introduction regarding features and usage of any Network simulator.

Recommended Books:

- Averill M. Law and W. David Kelton "Simulation Modeling and Analysis", Tata McGraw-Hill Publication.
- Geoffery Gordon ""System Simulation", Prentice-Hall of India.
- RudraPratap "Getting Started with MATLAB 7", Oxford University Press.

Course Code	Course Name	L-T-P	Credits
CSL4667	Network Programming	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Describe and analyze the hardware, software, components of a network and the interrelations.

CLO.2 Explain networking protocols and their hierarchical relationship hardware and software.

CLO.3 Compare protocol models and select appropriate protocols for a particular design.

CLO.4 Manage multiple operating systems, systems software, network services and security.

CLO.5 Explain concepts and theories of networking and apply them to various situations, classifying networks, analyzing performance and implementing new technologies.

CLO.6 Imparting skills to analyze, specify and design the topological and routing strategies for an IP based networking infrastructure

CLO.7 Identify infrastructure components and the roles they serve, and design infrastructure including devices, topologies, protocols, systems software, management and security.

CLO.8 Effectively communicate technical information verbally, in writing, and in presentations.

Course Outline:-
INTRODUCTION
Overview of UNIX OS, Environment of a UNIX process, Process control, Inter process Communication, Process synchronization using semaphores.
BASICS OF TCP SOCKETS
Introduction to Socket Programming ,Introduction to Sockets , Socket address Structures, Byte ordering functions ,address conversion functions , Elementary TCP Sockets ,socket, connect, bind, listen, accept, read, write , close functions.
TCP SOCKET MULTIPLEXING

TCP Echo Server , TCP Echo Client ,boundary conditions: Server process Crashes, Server host Crashes, Server Crashes and reboots, Server Shutdown , I/O multiplexing , I/O Models , select function ,TCP echo Server (with multiplexing) ,poll function, TCP echo Client (with Multiplexing)

ELEMENTARY UDP SOCKETS

Elementary UDP sockets, UDP echo Server, UDP echo Client, Multiplexing TCP and UDP sockets, Domain name system, get host by name function, get host by adr function

ADVANCED SOCKETS

Threaded servers, Thread creation and termination, TCP echo server using threads, socket options, raw sockets, raw socket creation, raw socket output, raw socket input, ping program.

Web Services - Introducing Web services, REST and SOAP, Web services in Python
Web Applications - Web applications and frameworks, Django, Web2py, Flask, Bottle Python Web development

Recommended Books

- W. Richard Stevens, B. Fenner, A.M. Rudoff, "Unix Network Programming – The Sockets Networking API", 3rd edition, Pearson, 2004.
- W. Richard Stevens, S.A Rago, "Programming in the Unix environment", 2nd edition, Pearson, 2005

Course Code	Course Name	L-T-P	Credits
CSL4668	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

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

Course Code	Course Name	L-T-P	Credits
CSL4669	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.

Multi biometrics and multi factor biometrics-two-factor authentication with passwords, tickets and tokens, executive decision, implementation plan, Securing Biometric Template-Cancelable Biometrics, Authentication, Security Analysis.

Recommended Books:

Samir Nanavathi, Michel Thieme, and Raj Nanavathi : "Biometrics -Identity verification in a network", 1st Edition, Wiley Eastern, 2002.

John Chirillo and Scott Blaul : "Implementing Biometric Security", 1st Edition, Wiley Eastern Publication, 2005.

John Berger: "Biometrics for Network Security", 1st Edition, Prentice Hall, 2004.

Course Code	Course Name	L-T-P	Credits
ECL4627	System Implementation of Vision	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Identify basic skills of concepts, terminology, theories, models and methods in the field of computer vision,

CLO.2 Describe known principles of human visual system

CLO.3 Describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition,

CLO.4 Suggest a design of a computer vision system for a specific problem

Image acquisition, Image properties. Intel Arduino/Galileo interfacing and Understanding of video components

Course Outline:-

Practical significance of Fourier transform and convolution in image understanding. Quantization, Basic relationship between pixels, Linear and Non-Linear operations. The algorithm to track lines in the image. Pattern recognition techniques.

Introduction to Python and its implementation: Constants and Variables, First Program, Conditional Programming Loops and Iterations, Image Acquisition, Implementing pattern recognition, Decision making Motion Vision Shaping with binary and shaded images Binary image processing Stereo photogrammetry Computational Vision (Machine learning and vision) Performance Evaluation Projects using Machine vision (Any of the following) Vision in Agriculture, Vision in Natural Language Processing, Vision in Biomedical, Vision in Education.

Object Recognition - Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values.

Recommended Books

- "Learning OpenCV: Computer Vision with the OpenCV Library", By Gary Bradski, Adrian Kaehler.
- "Computer Vision: Algorithms and Applications", Richard Szeliski.

Course Code	Course Name	L-T-P	Credits
CSL4652	Speech and Signal Processing	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Understand production of speech.
CLO.2 Analyze time domain models for speech signals.
CLO.3 Analyze linear predictive coding techniques.
CLO.4 Illustrate the homomorphic speech processing.
CLO.5 Analyze the speech enhancement skill techniques.

Course Outline:-

Digital Models For The Speech Signal: Process of speech production, Acoustic theory of speech production, Lossless tube models, and Digital models for speech signals.

Time Domain Models for Speech Processing: Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech vs silence discrimination using energy & zero crossings, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function, Median smoothing.

Digital Representations of the Speech Waveform: Sampling speech signals, Instantaneous quantization, Adaptive quantization, Differential quantization, Delta Modulation, Differential PCM, Comparison of systems, direct digital code conversion.

Short Time Fourier Analysis: Linear Filtering interpretation, Filter bank summation method, Overlap addition method, Design of digital filter banks, Implementation using FFT, Spectrographic displays, Pitch detection, Analysis by synthesis, Analysis synthesis systems.

Homomorphic Speech Processing: Homomorphic systems for convolution, Complex cepstrum, Pitch detection, Formant estimation, Homomorphic vocoder. Linear Predictive Coding of Speech: Basic principles of linear predictive analysis, Solution of LPC equations, Prediction error signal, Frequency domain interpretation, Relation between the various speech parameters, Synthesis of speech from linear predictive parameters, Applications.

Speech Enhancement: Spectral subtraction & filtering, Harmonic filtering, parametric re-synthesis, Adaptive noise cancellation.

Speech Synthesis: Principles of speech synthesis, Synthesizer methods, Synthesis of intonation, Speech synthesis for different speakers, Speech synthesis in other languages, Evaluation, Practical speech synthesis. Automatic Speech Recognition: Introduction, Speech recognition vs. Speaker recognition, Signal processing and analysis methods, Pattern comparison techniques, Hidden Markov Models, Artificial Neural Networks.

Audio Processing: Auditory perception and psychoacoustics - Masking, frequency and loudness perception, spatial perception, Digital Audio, Audio Coding - High quality, low-

bit-rate audio coding standards, MPEG, AC- 3, Multichannel audio - Stereo, 3D binaural and Multichannel surround sound.

Recommended Books:

- L. R. Rabiner and R. W. Schafer, "Digital Processing of Speech Signals", Pearson Education (Asia) Pte. Ltd., 2004.
- D. O'Shaughnessy, "Speech Communications: Human and Machine", Universities Press, 2001.
- L. R. Rabiner and B. Juang, "Fundamentals of Speech Recognition", Pearson Education (Asia) Pte. Ltd., 2004. Z. Li and M.S. Drew, "Fundamentals of Multimedia", Pearson Education (Asia) Pte. Ltd., 2004.

Course Code	Course Name	L-T-P	Credits
CSL4653	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.

Training Methods, Maximum Likelihood and Bayesian Parameter Estimation; Linear Discriminant/Perceptron Learning, Optimization by Gradient Descent; Support Vector Machines; K-Nearest-Neighbor Classification; Non-parametric Classification, Density

Estimation, Parzen Estimation

Recommended Books

- Robert Schalkoff, "Pattern Recognition: Statistical Structural and Neural Approaches", John wiley&sons , Inc,1992.
- Earl Gose, Richard johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall of India,.Pvt Ltd, New Delhi, 1996.
- Duda R.O., P.E. Hart & D.G Stork, " Pattern Classification", 2nd Edition, J.WileyInc 2001.
- Duda R.O.& Hart P.E., "Pattern Classification and Scene Analysis", J.wileyInc, 1973.
- Bishop C.M., "Neural Networks for Pattern Recognition", Oxford University Press, 1995.

Course Code	Course Name	L-T-P	Credits
ICP4306	Mobile Application Development	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Install and configure Android application development tools.
CLO.2 Design and develop user Interfaces for the Android platform.
CLO.3 Save state information across important operating system events.
CLO.4 Apply Java programming skills and concepts to Android application development.

Course Outline:-

Introduction to Mobile Application Development: Definition of Mobile Computing, Devices: Mobile devices vs. desktop devices, Web-Based Applications, Native Applications, History of Mobile Platforms, Internet Protocols for Mobile Apps, Content vs. Applications. Mobile and Cell Phone Technologies, Internet Terms, Transport, Secure Connections. Power Management, Screen resolution, Touch interfaces, Application deployment, App Store, Google Play, Windows Store.

HTML5/JS/CSS3/DOM/JQuery: Quick recap of technologies, Mobile-specific enhancements, Browser-detection, Touch interfaces, Geolocation, Screen orientation, Mobile browser "interpretations" (Chrome/Safari/Gecko/IE), jQuery, JavaScript and XML.

Android/iOS/Win 8 Survival and basic apps: App-structure, built-in Controls, file access, basic graphics, Building a simple "Hello World" App in all three applications, DB access, network access, contacts/photos/etc.

Mobile User Interface and Server-access: Overview, Definition of Usability, Task Analysis and Contextual Inquiry, Development Cycle, Mobile User Interface Types, Mobile Application Development Design Considerations, XMLHttpRequest Implementations by Browser.

Mobile Application Evaluation, Mobile Browsers and Mobile Platforms: Mobile Device User Interaction Patterns, Evaluating Mobile User Interfaces, Mobile Browsers and

Browsers, Mobile Browser Evolution, URIs for Mobile Apps, Native Runtime Platforms, Cross-Platform Development

Location - Mobility and Location Based Services, Android

Putting It All Together (as time allows) - Packaging and Deploying, Performance Best Practices, Android Field Service App

Storage and Geolocation: Need for Storage, Local Storage with HTML5, Storage on the Web, Geolocation.

Recommended Books:

- "Professional Android 4 Application Development", Reto Meier, Wiley India
- "Professional iOS Programming: Covers iOS 7", Peter Van De Put , Wiley India

Course Code	Course Name	L-T-P	Credits
CSL4670	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's self 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:

- Stuart J. Russel, Norvig : AI: A Modern Approach, Pearson Education, Latest Edition
- Michael Negnevitsky : Artificial Intelligence: A Guide to Intelligent Systems, 2/E, Addison-Wesley, 2005
- Yegnanarayana B : Artificial Neural Networks, Prentice Hall of India Private Ltd., New Delhi,

1999.

- Hagan, M.T., Demuth, Mark Beale : Neural Network Design By Cengage Learning
- Goldberg, David E. : Genetic algorithms in search, optimization and machine learning, Latest Edition, Addison Wesley

Course Code	Course Name	L-T-P	Credits
PRM4101	Research Methodology	4-0-0	4

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1: Start a carrier in research.

CLO.2: Can gain skill and decide about various tools and techniques which will help them in research for analysis, ethics, presentation and writing of research.

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.

RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING L-9 Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

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:

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

Course Code	Course Name	L-T-P	Credits
CSL2518	Intellectual Property Right	2-0-0	2

Course Learning Outcomes (CLO):

Students will be able to:

CLO.1 Recognize the importance of IP and to educate the pupils on basic concepts of Intellectual Property Rights.

CLO.2 Gain skills and identify the significance of practice and procedure of Patents.

CLO.3 Make the students to understand the statutory provisions of different forms of IPRs in simple forms.

CLO.4 Learn the procedure of obtaining Patents, Copyrights, Trade Marks &Industrial Design

CLO.5 Enable the students to keep their IP rights alive.

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).

Recommended Books and Study Material:

- Kompal Bansal and Parikshit Bansal, "Fundamentals of IPR for Engineers", B.S. Publications
- Cyber Law. Texts & Cases, South-Western's Special Topics Collections
- Prabhuddha Ganguly, "Intellectual Property Rights", Tata Mc Graw Hill, New Delhi
- www.ipindia.nic.in - Intellectual Property Office, India
- www.patentoffice.nic.in – Patent office, India

S. No.	Course Code	Title of the course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
1	CSL4631	Distributed Computing	CLO:1 Develop and apply knowledge of parallel and distributed computing skills and methodologies.										M
			CLO:2 Apply design, development, and performance analysis of parallel and distributed applications.					L					
			CLO:3 Use the application of fundamental Computer Science methods and algorithms in the development of parallel applications.		M								
			CLO:4 Explain the design, testing, and performance analysis of a software system, and to be able to communicate that design to others.	M									
			CLO:5 Develop and apply knowledge		L								

No	Course Code	Course Name	Course Learning Outcome (CLO)												
			of parallel and distributed computing techniques and methodologies.												
2	CSP1631	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							
3	CSL4632	Advanced Data Structure	CLO:1 Gain skills to analyse algorithms and algorithm correctness.								L				
			CLO:2 Analyse time complexities of algorithms using asymptotic analysis.								M				
			CLO:3 Summarize searching and sorting techniques.		H										
			CLO:4 Describe stack, queue and linked list operation.												

#	Code	Course	CLO	1	2	3	4	5	6	7	8	9	10	11
			And can compare between different data structures. Pick an appropriate data structure for a design situation.											
4	CSP1632	Advanced Data Structure Lab	CLO:1 Implement skills to analyse algorithms and algorithm correctness.		H									
			CLO:2 Implement and analyse time complexities of algorithms using asymptotic analysis.		H									
5	CSL4633	Information Security	CLO:1 Review and practice computer and network etiquette and ethics found in working environments	M										
			CLO:2 Perform risk assessment							M				
			CLO:3 Install, configure, use and manage anti malware software on a working network	M										

No	Code	Course	CLO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
			CLO:4 Evaluate best practices in security concepts and skills to maintain confidentiality, integrity and availability of computer systems		H											
			CLO:5 Articulate informed opinion about issues related to cyber security		H											
6	ECL4606	Digital Image Processing	CLO:1 Understand fundamental steps of digital image processing													H
			CLO:2 Examine various types of images, intensity transformations and spatial filtering.		M										M	
			CLO:3 Skill to understand and compare various image enhancement techniques		H											
			CLO:4 Skill to understand and implement basic image segmentation			M										

S.No	Code	Course	CLO	1	2	3	4	5	6	7	8	9	10	11	12	13
			techniques													
7	ECP1606	Digital Image Processing Lab	CLO:1 Implement fundamental steps of digital image processing	H												
			CLO:2 Implement various skills for types of images, intensity transformations and spatial filtering.											M		
8	CSL4502	Advanced Computer Networks	CLO:1 Understand the main abstract concepts related to the layered communication architecture												H	
			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).												H	
			CLO:3 Understand basics and principles of new generation of	M												

			computer networking infrastructure (VoIP, SIP, RTP).											
			CLO:4 Practice Networking Simulating skills as employed in Industry for Planning and Design (CISCO Packet Tracer).	H								M		
9	CSP1502	Advanced Computer Networks Lab	CLO:1 Understand the captured data by using the relevant tools and focus on the involvement of layered approach in data transmission.				H							
			CLO:2 Enhance the analytical skills of the students to understand and simulate the working of TCP/IP reference model.				M							
11	CSL4625	Programming in C#	CLO:1 Implement the concept of object-oriented techniques and methodologies using c#		M	L								
			CLO:2 Use Exception Handling concepts		M	L								

No.	Course Code	Course Name	CLO											
			and skills for a Robust Application in c#.											
			CLO:3 Demonstrate an understanding of c# Input and Output			M	L							
			CLO:4 Develop applications using multithreading concept of c#.		M										L
12	CSL4626	Programming in Python	CLO:1 Run basic python programs.					M						
			CLO:2 Use python skills in various fields of Data Science, Machine Learning and Artificial Intelligence.					M						
			CLO:3 Logic building using looping and decision statements.		H									
			CLO:4 Develop problem solving abilities using Python.				H					L		
			CLO:5 Learn building packages and modules for reusability.			H				L				
			CLO:6 Learn GUI development using Widgets in Python.			H				L				
13		Programming	CLO:1 Use R skills in various fields of Data Science, Machine			L								

	CSL4661	in R	Learning and Artificial Intelligence.													
			CLO:2 Logic building using looping and decision statements.				L									
			CLO:3 Develop problem solving abilities using R					M								
			CLO:4 Learn building packages and modules for reusability.						L							
			CLO:5 Learn GUI development using Widgets in R.							M						
14	CSL4635	Advanced Database Management Systems	CLO:1 Understand and gain skills functionality of the various database systems.	H												
			CLO:2 Practice the codes and study about the case studies.											M		
15	CSP1635	Advanced Database Management Systems Lab	CLO:1 Learn the installation of the software.	H												
			CLO:2 Practice the codes to gain better skills of knowledge.											H		
16	CSL4636	Advanced Software	CLO:1 Acquire strong fundamental knowledge in science, mathematics,		H											

Engineering	fundamentals of computer science, software engineering and multidisciplinary engineering to begin in practice as a software engineer.													
	CLO:2 Design applicable solutions in one or more application domains using software engineering approaches that integrate ethical, social, legal and economic concerns.				H									
	CLO:3 Deliver quality software products by possessing the leadership skills as an individual or contributing to the team development and demonstrating effective and modern working strategies by applying both communication and negotiation management skill.					H								

#	Code	Course	CLO	1	2	3	4	5	6	7	8	9	10	11
			CLO:4 Apply new software models, techniques and technologies to bring out innovative and novelistic solutions for the growth of the society in all aspects and evolving into their continuous professional development.					M						
17	CSL4671	Software Testing and Quality Assurance	CLO:1 Understand software testing and quality assurance as a fundamental component of software life cycle					M						
			CLO:2 Infer various software models concepts and skills for making the software.		M							L		
			CLO:3 Analyse software creating requirements to determine the entities involved in the system and their relationship to one another.	H										
			CLO:4 To make sure that the result meets the business and user		M									

			requirements Software testing plays an instrumental role.											
			CLO:5 Also, to satisfies the BRS that is Business Requirement Specification and SRS that is System Requirement Specifications and finally gain the confidence of the customers by providing them a quality product.		M								L	
18	ECL4602	Next Generation Wireless and Sensor Networks	CLO:1 Implement skill based knowledge of routing mechanisms and the three classes of approaches: proactive, on-demand, and hybrid										M	
			CLO:2 Study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.		M									

No	Code	Course	CLO										
			CLO:3 Identify the issues and challenges in providing QoS		H								
			CLO:4 Explain about the energy management in ad-hoc networks									M		
			CLO:5 Demonstrate various types of mesh networks.									L		
19	CSL4662	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.		H									
			CLO:2 Students will be able to explain the core issues of cloud computing such as security, privacy, and interoperability.				H					L		
			CLO:3 Students will be able to provide the appropriate cloud computing solutions and recommendations according to the applications used.				H			L				

	Course Code	Course Name	CLO											
			CLO:4 Students will be able to build skills to generate new ideas and innovations in cloud computing.			H				L				
			CLO:5 Students will be able to identify problems, and explain, analyze, and evaluate various cloud computing solutions.		H									
20	CSL4663	Natural Language Processing	CLO:1 Learning the basic concepts and skills of Artificial Intelligence.				H				L			
			CLO:2 Represent Knowledge using propositional calculus and predicate calculus.			H				L				
			CLO:3 Use inference rules to produce predicate calculus expression.			H				L				
			CLO:4 Demonstrate awareness of informed search and uninformed search techniques.			H								
			CLO:5 Explain about AI techniques for planning, knowledge				H					L		

#	Code	Course	CLO										
			representation and management.										
			CLO:6 Outline the process involved in Expert systems and in building such systems.				H			L			
21	CSL4651	Engineering Education	CLO:1 Attain a position solving real-world problems using mechanical engineering skills and principles developed while studying at Seattle University				H			L			
			CLO:2 Participate in ongoing personal and professional growth by actively seeking additional skills and experiences, for example engaging in continuing education and/or pursuing advanced degrees		H								
			CLO:3 Contribute to society through involvement in professional organizations, developing mentorship				H			L			

No	Code	Course	CLO										
			relationships, taking on leadership roles, and other service activities.										
22	CSL4641	Big Data Technology	CLO:1 Understand and implement classical models and algorithms in machine learning as well as python programming concepts.		H				L				
			CLO:2 Analyze the data, identify the problems.		H				L				
			CLO:3 Learn the skills to analyze relevant models and algorithms to turn available data into valuable and useful Information.		H								
			CLO:4 Understand the comparative study of the related approaches.				H				L		
			CLO:5 Explore new techniques and ideas that can be used to improve the effectiveness of			H				L			

#	Code	Course	CLO												
			current AI tools.												
23	CSL4211	Advanced Algorithms	CLO:1 Analyze algorithms and algorithm correctness.				H				L				
			CLO:2 Analyze time complexities of algorithms using asymptotic analysis.	H											
			CLO:3 Summarize searching and sorting techniques.				H				L				
			CLO:4 Describe stack, queue and linked list operation. Compare different data structures and pick an appropriate data structure for a design situation.			H				L					
			CLO:5 Explain the major graph and tree algorithms and their analysis skills. Employ graphs to model engineering problems.			H				L					
24	CSL4212	Data mining & Machine learning	CLO:1 Understand and implement classical models and algorithms in machine learning as well as			H									

		python programming concepts.												
		CLO:2 Analyze the data, identify the problems.							H				L	
		CLO:3 Learn the skills to analyze relevant models and algorithms to turn available data into valuable and useful Information.							H				L	
		CLO:4 Understand the comparative study of the related approaches.							H				L	
		CLO:5 Explore new techniques and ideas that can be used to improve the effectiveness of current AI tools.			H									
ECL2601	Publishing Research	CLO:1 Understanding of ethical issues related to Research and Publication.	M					L						
		CLO:2 Gain skills to write research papers/thesis following publication ethics.Related issues.										M		

#	Code	Course	CLO											
			CLO:3 Gain skills to Publish ethically.		M									
			CLO:4 Gain skills to for avoiding plagiarism.			L								
25	CSL4664	Requirement Elicitation	CLO:1 Establish a structure and process for gathering skill and information through interviews and group sessions					H			L			
			CLO:2 Conduct a successful skilful information gathering session				H			L				
			CLO:3 Identify and deal with interview and meeting problems				H			L				
			CLO:4 Catch and clarify assumptions and misinformation				H							
			CLO:5 Facilitate and mediate among the participants						H				L	
26	CSL4665	Software Project Management	CLO:1 To acquire presentation and communication skills					H			L			
			CLO:2 Undertake problem identification, formulation and solution to make					H			L			

Sr. No	Course Code	Course Name	CLO	1	2	3	4	5	6	7	8	9	10	11	12
			students employable.												
			CLO:3 Design engineering solutions to complex problems utilizing a systems approach			H									
			CLO:4 To implement learning in real life problem for skill development					H				L			
			CLO:5 To propose multiple solution to any given problem and find best out of those.				H				L				
27	CSL4666	Modelling and Simulation	CLO:1 Understand the techniques of modelling in the context of hierarchy of					H			L				
			CLO:2 Gain skill and knowledge about a system and develop the capability to apply the same to study systems through available software.			H									
			CLO:3 Students will learn different types of simulation techniques.					H				L			

#	Code	Course	CLO											
			CLO:4 Students will learn to simulate the models for the purpose of optimum control by using software.				H				L			
28	CSL4667	Network Programming	CLO:1 Describe and analyze the hardware, software, components of a network and the interrelations.				H				L			
			CLO:2 Explain networking protocols and their hierarchical relationship hardware and software.			H								
			CLO:3 Compare protocol models and select appropriate protocols for a particular design.					H				L		
			CLO:4 Manage multiple operating systems, systems software, network services and security.				H				L			
			CLO:5 Explain concepts and theories of networking and apply them to various situations, classifying networks, analyzing				H				L			

#	Code	Course	CLO											
			performance and implementing new technologies.											
			CLO:6 Imparting skills to analyze, specify and design the topological and routing strategies for an IP based networking infrastructure			H								
			CLO:7 Identify infrastructure components and the roles they serve, and design infrastructure including devices, topologies, protocols, systems software, management and security.					H				L		
			CLO:8 Effectively communicate technical information verbally, in writing, and in presentations.				H				L			
29	CSL4668	Virtual Private Network	CLO:1 Use highly secure VPN communications, with access rights tailored to individual users				H				L			

#	Course Code	Course Name	CLO									
			CLO:2 USe VPN products to add new sites or users, without significantly expanding your existing infrastructure			H						
			CLO:3 Extend skills of corporate networks, applications, and collaboration tools by using VPN						H			L
			CLO:4 Reduce communications costs while increasing flexibility					H		L		
30	CSL4669	Biometric Security	CLO:1 Apply biometric matching for identification					H		L		
			CLO:2 Identify algorithms for finger biometric technology			H						
			CLO:3 Apply skills of facial biometrics for identification.						H			L
			CLO:4 Apply iris biometric, voice biometric, physiological biometrics etc. for identification.					H		L		
31		System	CLO:1 Identify basic skills of concepts,					H		L		

No	Course Code	Course Name	CLO												
	ECL4627	Implementation of Vision	terminology, theories, models and methods in the field of computer vision,												
			CLO:2 Describe known principles of human visual system			H									
			CLO:3 Describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition,					H				L			
			CLO:4 Suggest a design of a computer vision system for a specific problem				H				L				
32	CSL4652	Speech and Signal Processing	CLO:1 Understand production of speech.				H				L				
			CLO:2 Analyze time domain models for speech signals.			H									
			CLO:3 Analyze linear predictive coding techniques.					H				L			
			CLO:4 Illustrate the homomorphic speech processing.				H				L				

S.No	Code	Course	CLO											
			CLO:5 Analyze the speech enhancement skill techniques.				H					L		
33	CSL4653	Pattern Recognition	CLO:1 Understand and gain skills of basic concepts in pattern recognition			H								
			CLO:2 Gain knowledge about state-of-the-art algorithms used in pattern recognition research					H				L		
			CLO:3 Understand pattern recognition theories, such as Bayes classifier, linear discriminant analysis.				H					L		
			CLO:4 Apply pattern recognition techniques in practical problems.				H					L		
34	ICP4306	Mobile Application Development	CLO:1 Install and configure Android application development tools.			H								
			CLO:2 Design and develop user Interfaces for the Android platform.					H				L		

			CLO:3 Save state information across important operating system events.				H					L		
			CLO:4 Apply Java programming skills and concepts to Android application development.				H					L		
35	CSL4670	Soft Computing	CLO:1 Learn about soft computing skills and techniques of their applications			H								
			CLO:2 Analyze various neural network architectures					H					L	
			CLO:3 Understand perceptrons and counter propagation networks.				H					L		
			CLO:4 Define the fuzzy systems				H					L		
			CLO:5 Analyze the genetic algorithms and their applications.			H								
36	PRM4101	Research Methodology	CLO:1 Start a carrier in research.					H					L	
			CLO:2 Can gain skill and decide about various tools and techniques which will help them in research				H					L		

			for analysis, ethics, presentation and writing of research.												
37	CSL2518	Intellectual Property Right	CLO:1 Recognize the importance of IP and to educate the pupils on basic concepts of Intellectual Property Rights.				H				L				
			CLO:2 Gain skills and identify the significance of practice and procedure of Patents.			H									
			CLO:3 Make the students to understand the statutory provisions of different forms of IPRs in simple forms.					H				L			
			CLO:4 Learn the procedure of obtaining Patents, Copyrights, Trade Marks &Industrial Design				H				L				
			CLO:5 Enable the students to keep their IP rights alive.				H				L				