**SRI SANKARA ARTS AND SCIENCE COLLEGE**

**(AUTONOMOUS)**

**ENATHUR, KANCHIPURAM – 631 561.**

# Learning Outcome-based Curriculum Framework (LOCF)

for

**M.SC. COMPUTER SCIENCE**

**Choice Based Credit System (CBCS)**

**(Effective from the academic year 2022 - 2023)**

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**Preamble**

The curriculum of **M.Sc., Computer Science** programme offered by Department of Computer Science is prepared in accordance with UGC and Tamil Nadu State Council of Higher Education (TANSCHE). The Programme complies with the Outcome Based Education (OBE) and is designed with relevance to Choice Based Credit System (CBCS) affiliated to the University of Madras.

The curriculum and syllabi conform to the Learning Outcomes-based Curriculum Framework (LOCF) to make it student-centric, interactive and outcome-oriented education for the student's community. The Programme Outcome (PO), Programme Specific Outcome (PSO) and Course Outcome (CO) were discussed and finalized keeping the broad requirements of the programme.

Since the curriculum is intended for the post-graduate students, more emphasis is laid on inculcating research aspects through the curriculum. To cater to the needs of advanced learners, the curriculum is structured to include higher-end technologies and research-oriented software that are prevalent in the job-market. To facilitate graduates to be successful in competitive exams, the syllabi is made to focus on core-competent subjects as part of the curriculum.

A comprehensive and detailed curriculum and syllabi along with Text books and Reference books were framed in a structured approach by deploying Feedback Mechanism on Curriculum from various stakeholders viz. Industry, Potential Employers, Alumni, Academia, Research Organizations and Parents to capture the voice of the respective stakeholders.

The students are offered a well-rounded curriculum that are research-oriented and advanced subjects such as such as Microservices Architecture, communication Network and Wireless Technology, Artificial Neural Network, Internet of Things, parallel computing, among many other courses.

## 1. Introduction

The field of Computer Science has been on an evolution spree for the past three decades and the state-of-the-art technologies have often been breached day-in and day-out by the emergence of new technologies. The mutual growth of hardware and software has supplemented and complimented each other to propel the field of computer science and expanded the horizons of the field. Computers have invaded into every form of human lives giving them instant solutions for the problems that they encounter in their daily life. So, its safe to say that computers have become an integral part of humankind and inevitable to stay away from its magic.

The field of Computer science has been stretching its contours at a rapid pace so much so that even highly complex problems are being breached with consummate ease with the ever-evolving cutting-edge technologies. The latest topics that are hogging the limelight of late are Machine Learning, Artificial Intelligence, Internet of things, Image Processing, Cloud Computing, Natural Language Processing, etc.,

The M.Sc. Computer Science programme aims to instill research-oriented skillsets through introduction of theoretically complex subjects and higher-end technologies that trains the students to seek computational solutions for complex real-life and real-time problems. The curriculum is designed so as to enhance the research and problem-solving capabilities, entrepreneurship skill, and skill necessary for cracking the competitive exams such as SET and NET. In particular, the course prepares the students to be employable as Web Developer, Network Administrator, Database Administrator, Data Analyst and a Research Scholar.

The Learning Outcomes-based Curriculum Framework for M.Sc. CS is structured and developed to facilitate the students to achieve the following:

- To acquire basic core competencies in research-oriented papers and higher-end technologies such as Digital Image Processing, Microservices Architecture, Algorithms Design, Communication and Networking.
- To develop an ability to synthesize the learned knowledge to analyze the real-world problems and to propose new self-thought solutions from the acquired knowledge.
- To learn advanced and latest technologies to meet the industry standards and challenges. The course outcomes and objectives are designed to cater to the enlisted purposes.

## 2. Learning Outcomes-based Curriculum Framework

### 2.1. Nature and Extent of the M.Sc. CS Programme

The postgraduate programme in Computer Science builds on to the fundamental knowledge gained in undergraduate programme, which infuses core-competencies in Computer Science and basic programming languages. This creates a temperament for research among technology-savvy graduates.

Curriculum and syllabi framework is intended to introduce students to the advanced computing concepts and higher-end technologies and its applications. It is highly critical in inculcating a strong research-temper in computer science so as to venture into a advanced research and equips them to solve highly complex problems in of computer science. The curriculum in computer science is reinforced with internship and main-project work to expose the graduates to the corporate standards and procedures and introduce them to hands-on problems.

## 3. Graduate Attributes:

Graduate Attributes (GA) are the qualities, skills and understandings that students should develop during their graduation. These qualities prove to be the characteristics and defining roles of the graduates. Graduate attribute is a key outcome that underpin curriculum planning and development. The graduate attributes are fostered through meaningful learning experiences made available through the curriculum, college experience and a process of critical and reflective thinking.

The graduate attributes can be viewed as qualities as listed subcategories:

- **Disciplinary knowledge:**

  The graduate must demonstrate comprehensive and in-depth knowledge and understanding of the core concepts offered in the curriculum of Computer Science.

- **Intellectual Rigour:**

  Intellectual Rigour is the commitment to excellence in all scholarly and intellectual activities, including critical judgement. This capability involves engaging constructively and methodically when exploring ideas and theories. It also relates to the ability to analyse and construct knowledge with depth, insight and intellectual maturity.

- **Life-Long Learning:**

The skill of being a lifelong learner means a graduate is open, curious, willing to investigate and consider new knowledge and ways of thinking. This flexibility of mind means they are amenable to new ideas and actively seek out new ways of learning or understanding the real-world problems.

- **Problem Solving and Design:**

Problem solving skills empower students to find methodical solutions to any real-world problems or real-time problems using computational algorithms and solutions. Problem solvers are most sought-after attributes of the graduates form the field of Computer Science. They should possess the ability to clearly understand the problem, think creatively or out-of-the-box thinking and to convert the problem into a computational model to find a scientific solution backed by the theories.

- **Self-Management:**

Graduates must have capabilities for self-organization, self-review, personal development and life-long learning.

### 3.1. LIST OF GRADUATE ATTRIBUTES FOR B.SC CS:

**GA-1**: Ability to think carefully, deeply and with rigour when faced with new knowledge and arguments.

**GA-2**: Ability to develop creative and effective response to intellectual, professional and social challenges.

**GA-3**: Ability to be responsive to change, to be inquiring and reflective in practice, through information literacy and autonomous, self-managed learning.

**GA-4**: Ability to understand, design and analyse precise specifications of algorithms, procedures and interaction behaviour.

**GA-5:** Ability to be equipped with a range of fundamental principles of Computer Science that will provide the basis for future learning and enable them to adapt to the constant rapid development of the field.

**GA- 6**: Ability to synthesize alternative/innovative solutions, concepts and procedures.

## 4. Qualification Descriptors:

Qualification Descriptors are generic statements that define the outcomes of the graduates. The Qualification descriptors are used as metric by two parties:

The first party is the designer of academic programmes who can use the qualification metrics to measure the achievement of students for the award of the qualification.

The second party is the employers of the graduates who can use the qualification descriptors to assess the quality and capabilities of the graduates holding the qualification.

### 4.1. Qualification Descriptors for M.Sc. with CS

On completion of M.Sc. with Computer Science, the expected learning outcomes that a student should be able to demonstrate are the following.

**QD-1**: Procedural knowledge that creates different types of professionals related to Computer Science, including research and development, teaching and industry, government and public service.

**QD-2**: Use knowledge, understanding and skills required for identifying problems and issues, collection of relevant quantitative and qualitative data drawing on a wide range of sources and their application, analysis and evaluation using methodologies as appropriate to Computer Science for formulating solutions.

**QD-3:** Meet one's own learning needs, drawing on a range of current research and development work and processional materials.

**QD-4**: Communicate the results of studies undertaken in Computer Science accurately in a range of different contexts using main concepts, constructs and techniques.

**QD-5**: Demonstrate subject-related and transferable skills that are relevant to industry and employment opportunities.

## 5. PROGRAM OUTCOMES ( PO )

**PO-1.** Enriching the knowledge in theoretical and practical aspects.

**PO-2.** Developing research aptitude among the students and encouraging them to take up research projects and publish research papers.

**PO-3.** Enabling the students to come out successfully in competitive examinations.

**PO-4.** Developing students' skills, based on current trends by offering Job oriented, Entrepreneurial, certificate courses and Value-added courses.

## PROGRAMME SPECIFIC OUTCOME ( PSO )

**PSO-1.** Ability to apply knowledge of basic sciences, mathematics, statistics and physics into computer science for solving real world problems.

**PSO-2.** Ability to learn various software tools, programming languages and apply algorithmic models thus making them more employable.

**PSO-3.** Students equipped with state-of-the-art technologies and cutting-edge solutions so as to enable them to foray into Entrepreneurship.

**PSO-4.** Students enriched with requisite and holistic skills to embrace themselves for competitive exams like NET, SET and other exams for career prospects.

**PSO-5.** Students with a drive and passion for Research aptitude and motivated enough for venturing into Advanced Research.

**PO – PSO MATRIX**

| | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** |
|---|---|---|---|---|---|
| **PO-1** | ✓ | | | | |
| **PO-2** | | | | | ✓ |
| **PO-3** | | | | ✓ | |
| **PO-4** | | ✓ | ✓ | | |

## 6. REGULATIONS :

### (CHOICED BASED CREDIT SYSTEM)

**Knowledge levels for assessment of Outcomes based on Blooms Taxonomy**

| Sl.No | Level | Parameter | Description |
|---|---|---|---|
| 1 | K1 | Knowledge / Remembering | It is the ability to remember the previously learned |
| 2 | K2 | Comprehension / Understanding | The learner explains ideas or concepts |
| 3 | K3 | Application / Applying | The learner uses the information in a new way |
| 4 | K4 | Analysis / Analysing | The learner distinguishes among different concepts |
| 5 | K5 | Evaluation / Evaluating | The learner justifies a stand or decision |
| 6 | K6 | Synthesis / Creating | The learner creates a new product of point of view |

### 6.1 CBCS SYSTEM :

All programmes (named after the core subject) mentioned earlier shall be run on **Choice Based Credit System (CBCS).** It is an instructional package developed to suit the needs of students to keep pace with the developments in higher education and the quality assurance expected of it in the light of liberalization and globalization in higher education

### 6.2 ELIGIBILITY FOR ADMISSION:

Candidates with B.Sc. degree in Computer Science or Computer Science & Technology or B.C.A. degree of this University or any other degree accepted as equivalent thereto by Academic Council of the Autonomous College shall be eligible for admission to M.Sc Computer Science Degree Course.

### 6.3 ELIGIBILITY FOR THE AWARD OF DEGREE

A Candidate shall be eligible for the award of the Degree only if he / she has undergone the prescribed course of study in a Autonomous College for a period of not less than two academic years, passed the examinations of all the Four Semesters prescribed earning 91 credits in Parts-I, II, III, IV & V and fulfilled such conditions as have been prescribed therefore. The parent university will award degrees to the students evaluated and recommended by autonomous

colleges.

### 6.4 DURATION

Each academic year shall be divided into two semesters. The first academic year shall comprise the first and second semesters, the second academic year the third and fourth semesters respectively.

The odd semesters shall consist of the period from June to November of each year and the even semesters from December to April of each year. There shall be not less than 90 working days for each semester exclusive of the days for the conduct of semester examinations.

In each semester, Courses are administered in 15 teaching weeks and another 5 weeks are utilized for evaluation and grading purposes. Each week has 30 working hours spread over in a 5 day week. Depending upon the content and specialization, a paper may have 1 to 6 credits. Total number of teaching hours in a semester will be 450 hrs.

### 6.5 MAXIMUM PERIOD FOR COMPLETION OF THE PROGRAMMES

The candidates shall complete the Masters Degree Programmes within 4 years from the date of admission. The term completing the programmes means passing all the prescribed examinations of the programme to become eligible for the degree. No candidate shall be permitted to appear for the examinations after the prescribed period for completing the programme.

### 6.6 MEDIUM OF INSTRUCTION

The medium of instruction shall be English.

### 6.7 COURSE OF STUDY

A Master's programme consists of a number of courses (papers). The term Course is used to indicate logical part of a subject matter of the programme. In each of Master"s programmes, there will be a prescription of (i) Part –I (Core subjects – Theory, Practicals, Project, and Field work), (ii) Part – II (Elective subjects – Inter disciplinary or Extra disciplinary subjects), (iii) Part – III: a set of papers recommended by UGC and TANSCHE (Soft skills), (iv) Part – IV: Internship, and (v) The detail of the Study for Master Degree Courses shall consist of the following:

**PART – I** Core Subjects – Theory, Practicals, Project / Field work PG students shall be required to take up Project / Field Work and submit the Project Report during the second year. The Head of the Department shall allot the Guide who in turn will suggest the Project Work to the students. Two typed copies of the Project Report shall be submitted to the Department before the due date and one copy will be forwarded to the Controller of Examinations. For the

Project Report, the maximum internal marks will be 20 percent, the maximum external marks will be 60 per cent and for the Viva-Voce 20 per cent (If in some programmes, if the project is equivalent to more than one paper, the project marks would be in proportion to the number of equivalent papers). Each student shall be required to appear for Viva-Voce Examination in defence of the Project only.

**PART – II** Elective Subjects – Inter-disciplinary or Extra-disciplinary or self study elective or openelective

**PART – III** Skill Based Subjects - Soft Skills

A candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed papers on Soft Skills. For three years PG degree Programme, a candidate must undergoa minimum of 2 papers (2 x 2 = 4 credits). Papers will be finalized in due course.

**PART – IV** Internship

Each PG student shall appear for intenship training during the vacation of II Semester for a minimum period of 15 days and shall submit the report to the controller of examinations. Each student is allotted 4 credits on submission of the report.

**Course:** Every course offered will have three components associated with the teaching learning process of the paper, namely (i) Lecture - L (ii) Tutorial - T (iii) Practicals - P, (iv) Self study - S where

**L** stands Lecture session. **T** stands Tutorial session consisting participatory discussion / self study / desk work / brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.

**P** stands Practice session and it consists of Hands on experience / Laboratory Experiments / Field Studies / Case studies that equip students to acquire the much required skill component.

**S** stands Self study session consisting participatory discussion by student with the guidance of faculty. This session is not included in the weekly hour plan.

In terms of credits, every one hour session of L amounts to 1 credit per semester, a minimum oftwo hour session of T or P amounts to 1 credit per semester and no credits alloted to self studyhour, over a period of one semester of 15 weeks for teaching-learning process. The total duration ofa semester is 20 weeks inclusive of semester-end examination.

A paper shall have either or all the three components. That means a paper may have only lecture component, or only practical component or combination of any two or all the three components. The total credits earned by a student at the end of the semester upon successfully completing the paper are L + T + P + S. The credit pattern of the paper is indicated as L: T: P: S.

For example: a theory paper with a L-T-P-S schedule of 4-0-0-2 will be assigned 4 credits, and alab practical paper with a L-T-P-S schedule of 0-0-3-0 will be assigned 3 credits.

**The concerned Board of Studies will choose the convenient credit pattern for every paper based on the requirement. However, generally, a paper shall be of 2 - 6 credits.**

Different courses of study are labeled and defined as follows:

**Core Course**

A course which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main discipline / subject of study or from a sister/related discipline / subject which supports the main discipline / subject. In contrast to the phrase Soft Core, a compulsory core course is called a **Hard Core** Course**.**

**Elective Course**

Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline / subject of study or which provides an extended scope or which enables an exposure to some other discipline / subject / domain or nurtures the candidate‟s proficiency/ skill is called an Elective Course. Elective courses may be offered by the main discipline / subject of study or by sister / related discipline / subject of study. A Soft Core course may also be considered as an elective. An elective course chosen generally from an unrelated discipline / subject, with an intention to seek exposure is called an **open elective**. An elective course designed to acquire a special / advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher is called a **Self Study Elective**.

A core course offered in a discipline / subject may be treated as an elective by other discipline / subject and vice versa. Project work / Dissertation work is a special course involving

application of knowledge in solving / analyzing / exploring a real life situation / difficult problem. A project work up to 4 - 6 credits is called Minor Project work. A project work of 8 - 12 credits is called Major Project Work. Dissertation work can be of 8 - 12 credits. A Project / Dissertation work may be a hard core or a soft core as decided by the Board of Studies concerned.

**Student Advisor**

All teachers of the department shall function as student advisors. There will be more or less an equal number of students assigned to each student advisor of a department. The student advisor will help the students in choosing core and elective courses of study. The student advisor shall be responsible for registration of courses (subjects) by his students. The student advisor will offer all possible student support services.

## 6.8 CREDITS

The term credit is used to describe the quantum of syllabus for various programmes in terms of periods of study. It indicates differential weightage given according to the contents duration of the courses in the curriculum design. The minimum credit requirement for a two year Master"s programme shall be **91** credits. Each subject (course) is designed variously under lectures / tutorials / laboratory work / seminar / project work etc., to meet effective teaching and learning needs and credits are assigned suitably.

One credit for each lecture / tutorial / project work period per week shall be alloted. In practical, each credit should cover minimum of six experiments. One credit is alloted for two practical hours. Thus normally, in each of the subject, credits will be assigned on the basis of the lectures / tutorials / laboratory work / project work and other forms of learning in a 15 week schedule.

## 6.9 SCHEME OF EXAMINATION

There shall be continuous, comprehensive evaluation of students through internal and external examination. At least 2 internal examinations (Sessional Tests) per semester and 1 semester ending examination should be conducted.

**Sessional Test I** will he held during sixth week for syllabi covered till then. Sessional Test I will bea combination of a variety of tools such as class test, assignment, papr presentation etc., that would be suitable for the paper. This required an element of openness. The students are to be informed in advance about the nature of assessment and the procedures. However the tests

are compulsory. Test I may be for one hour duration. The pattern of question paper will be decided by the respective board of studies.

Sessional Test I will carry 20% of marks of the entire paper.

**Sessional Test II** will he held during eleventh week for syllabi covered between seventh and eleventh weeks. Sessional Test I will be a combination of a variety of tools such as class test, assignment, paper presentation etc., that would be suitable for the paper. It will also have an element of openness. The students are to be informed in advance about the nature of assessmentand the procedures. However the tests are compulsory. Test II may be for one hour duration. The pattern of question paper will be decided by the respective board of studies.

Sessional Test II will carry 20% of marks of the entire paper.

There will be one End Semester examination of 2 - 3 hours duration in each paper. The End semester examination will cover all the syllabi of the paper for 60% of Marks.

A dissertation may be offered in lieu of one / two papers / practicals. It shall be evaluated by two examiners one external and one internal appointed by the Controller of Examination. Wherever there is viva-voce, it shall be conducted by the common Viva Board consisting of the Chairman andinternal members of the Board of Examination in the concerned subject, internal guide and one external expert as approved by the Controller of Examinations. End semester practical examinations shall be held before the theory examinations to benefit the students to undertake examinations of other departments.

## 6.10 COURSE OF STUDY AND SCHEME OF EXAMINATIONS:

**First Semester**

| Course components | Name of Course | Semester | Credits | Exam. Duration | Max. Marks | |
|---|---|---|---|---|---|---|
| | | | | | IA | UE |
| Core – 1 | **Principles of Compiler Design** | I | 4 | 3 | 25 | 75 |
| Core – 2 | **Principles of Algorithm Design** | I | 4 | 3 | 25 | 75 |
| Core – 3 | **Distributed Computing** | I | 4 | 3 | 25 | 75 |
| Core – 4 | **Microservices Architecture** | I | 4 | 3 | 25 | 75 |
| Core – 5 | **Practical – I: Algorithms Designing Using JAVA Lab** | I | 2 | 3 | 40 | 60 |
| Core – 6 | **Practical – II: Microservices Architecture Lab.** | I | 2 | 3 | 40 | 60 |
| SoftSkill-1 | **Essentials of Language and Communication-1** | I | 2 | 3 | | |

**Second Semester**

| Course components | Name of Course | Semester | Credits | Exam. Duration | Max. Marks | |
|---|---|---|---|---|---|---|
| | | | | | CIA | UE |
| Core – 6 | **Digital Image Processing** | II | 4 | 3 | 25 | 75 |
| Core – 7 | **Unix and Perl Programming** | II | 4 | 3 | 25 | 75 |
| Core – 8 | **Practical – III: Unix and Perl Programming Lab** | II | 2 | 3 | 40 | 60 |
| Core – 9 | **Practical – IV: Digital Image Processing using Python Lab** | II | 2 | 3 | 40 | 60 |
| Elective I | **Elective – I** | II | 4 | 3 | 25 | 75 |
| Extra Disciplinary Elective -1 | **Theoretical Foundations of Computer Science** | II | 5 | 3 | 25 | 75 |
| SoftSkill-2 | **Spoken and Presentation Skills- Advanced Level** | II | 2 | 3 | 40 | 60 |
| SoftSkill-3 | | II | 2 | 3 | 40 | 60 |

**Third Semester**

| Course components | Name of Course | Semester | *Credits* | *Exam. Duration* | Max. Marks | |
|---|---|---|---|---|---|---|
| | | | | | CIA | UE |
| Core-10 | **Communication Network and Wireless Technology** | III | 4 | 3 | 25 | 75 |
| Elective | **Elective –II** | III | 4 | 3 | 25 | 75 |
| Elective | **Elective – III** | III | 4 | 3 | 25 | 75 |
| Core-12 | **Practical – V: Mini Project** | III | 4 | 3 | 40 | 60 |
| Extra Disciplinary Elective -2 | **Object Oriented Analysis and Design** | III | 4 | 3 | 25 | 75 |
| Soft Skill-4 | | III | 2 | 3 | 40 | 60 |
| Internship | **During summer vacation 4 to 6 weeks of I Year** | III | 2 | | | 100 |

**Fourth Semester**

| Course components | Name of Course | Semester | *Credits* | *Exam. Duration* | Max. Marks | |
|---|---|---|---|---|---|---|
| | | | | | CIA | UE |
| Core-14 | **Project & Viva-Voce** | IV | 20 | - | 20 | 60+ 20 |

**Elective - I**

Ethical Hacking OR Data Mining OR IoT

**Elective - II**

Artificial Neural Network OR Artificial Intelligence and Expert System OR Fundamentals of Machine Learning

**Elective - III**

Cryptography and Network security OR Distributed Database Management Systems OR Parallel Computing

Total of 30 hrs was maintained constantly for all semesters. Internship is compulsory and added in the third semester instead of soft skill. Self study elective is optional. Self study elective carries one credit.

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**Question Paper Pattern for External Examination**

**SECTION – A ( 50 words)**

10 out of 12 Questions - 10 X 1 marks = 10 marks

**SECTION – B ( 250 words)**

5 out of 7 Questions - 5X 5 marks = 25 marks

**SECTION – C (500 words)**

4 out of 6 Questions - 4 x 10 marks = 40 marks

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**TOTAL = 75 Marks**

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The offer of an Add-on Courses to the students in various disciplines is to enhance their employability. The number of working hours per week for the students for getting the 91 prescribed credits should not exceed 30 hours of class per week and no faculty member should be allocated extra hours beyond the prescribed 16 lecture hours.

Marks for continuous internal assessment (CIA) shall be awarded on the basis of tests, seminars, field work, assignment etc as determined by the Board of Studies in the respective subject. The internal assessment marks shall be notified on the department notice board for information of the students and it shall be communicated to the Controller of Examinations 5 days before the commencement of the End Semester examinations, and the Controller of Examinations shall have access to the records of such internal assessment evaluations.

The following procedure be followed for Internal Marks

Theory

Papers: Internal Marks 25

Theory based Continuous Internal Assessment (CIA)

- 25Tests (2 out of 3) = 10

Attendance* = 5

Seminars = 5

Assignments = 5

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25 marks

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A model practical examination is conducted for awarding CIA marks for practical. Question paper pattern for CIA examination is similar to the pattern of end semester examination as decided by Board of Studies.

Dissertation : Internal Marks : 40

External : 60

MarksTotal : 100

Each department has complete autonomy for designing and scheduling internal examinations / assignments. However transparency and objectivity shall be the main criteria. Records are to be maintained.

**6.11 INSTANT EXAMINATION**

Candidates who have passed all the theory papers upto 3rd semester and failed in only one paper pertaining to the 4th semester can apply for Instant Examination. Application form with a demand draft for Rs.400/-, drawn in favour of "The Principal, Sri Sankara Arts and Science College, Enathur" should be submitted on or before 10 days after the publication of results. The results arepublished within 15 days after the date of examinations.

## 6.12 REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTER

i. Candidates shall register their names for the First Semester Examination after the admission in PG Courses.

ii. Candidates shall be permitted to proceed from the First Semester up to Final Semester irrespective of their failure in any of the Semester Examination subject to the condition that the candidates should register for all the arrear subject of earlier semesters along the current (subsequent) Semester Subjects.

iii. Candidates shall be eligible to go to subsequent semester, only if they earn sufficient attendance as prescribed therefore by the Academic Council from time to time. Provided in case of a candidate earning less than 50% of attendance in any one of the Semesters due to any extraordinary circumstances such as medical grounds, such candidates who shall produce Medical Certificate issued by the Authorised Medical Attendant (AMA), duly certified by the Principal of the college, shall be permitted to proceed to the next semester and to complete the Course of study. Such Candidates shall have to repeat the missed Semester by rejoining after completion of Final Semester of the course, after paying the fee for the break of study as prescribed by the Academic Council from time to time.

iv. There shall be examinations at the end of each semester, for odd semesters in the month of October / November, for even semesters in April / May. A candidate who does not pass the examination in any paper(s) shall be permitted to appear in such failed papers in the subsequent examinations to be held in October / November or April / May.

v. The results of all the examinations will be published through the college Website.

## 6.13 PASSING MINIMUM

A candidate shall be declared to have passed:

a) There shall be no Passing Minimum for Internal.

b) For External Examination, Passing Minimum shall be of 50 % (Fifty Percentage) of the maximum marks prescribed for the paper for each Paper/Practical/Project and Viva-voce.

c) In the aggregate (External + Internal) the passing minimum shall be of 50%.

d) He/She shall be declared to have passed the whole examination, if he/she passes in all the papers and practicals wherever prescribed / as per the scheme of examinations by earning 91 CREDITS in Parts-I, II, III, IV & V. He / She shall also complete one certificate course to qualify for the Degree.

A candidate who fails in any of the unit / project work / Project Report / dissertation / viva-voice shall reappear in that unit / project work / Project Report / Dissertation / viva-voice and pass the examination subsequently.

## 6.14 CLASSIFICATION OF SUCCESSFUL CANDIDATES

PART- I CORE SUBJECTS (COURSE): Successful candidates passing the Examinations for the Language and securing the marks 60 percent and above in the aggregate shall be declared to have passed the examination in the FIRST Class. All other successful candidates shall be declared to have passed the examination in the SECOND Class.

PART – II ELECTIVE SUBJECTS (COURSE): Successful candidates passing the examinations for English and securing the marks 60 percent and above in the aggregate shall be declared to have passed the examination in the FIRST Class. All other successful candidates shall be declared to have passed the examination in the SECOND class.

PART – III Soft skill

Successful Candidate earning of 2 credits for soft skill paper SHALL NOT BE taken into consideration for Classification / Ranking / Distinction.

PART – IV INTERNSHIP

Successful Candidate earning of 2 credits for internship SHALL NOT BE taken into considerationfor Classification / Ranking / Distinction.

## 6.15 RANKING

Candidates who pass all the examinations prescribed for the Course in the FIRST APPEARANCE ITSELF ALONE are eligible for Ranking / Distinction. Provided in the case of Candidates who pass all the examinations prescribed for the Course with a break in the First Appearance due to thereasons as furnished in the Regulations 11(iii) category are only eligible for Classification.

## 6.16 APPEARANCE FOR IMPROVEMENT

Candidates who have passed in a theory paper / papers are allowed to appear again for theory paper / papers only once in order to improve his/her marks, by paying the fee prescribed from time to time. Such candidates are allowed to improve within a maximum period of 10 semesters counting from his/her first semester of his/her admission. If candidate improve his marks, then his improved marks will be taken into consideration for the award of Classification only. Such improved marks will not be counted for the award of Prizes / Medals, Rank and Distinction. If the candidate does not show improvement in the marks, his previous marks will be taken into consideration. No candidate will be allowed toimprove marks in the Practical, Project, Viva-voce, and Field work.

## 6.17 CONDONATION

Students must have 75% of attendance in each course for appearing the examination. Students who have 74% to 70% of attendance shall apply for condonation in the prescribed formwith the prescribed fee Rs.200/-.Students who have 69% to 60% of attendance shall apply for condonation in prescribed form with the prescribed fee along with the Medical Certificate. Students who have below 60% of attendance are not eligible to appear for the examination. They shall re-do the semester(s) after completion of the programme.

## 6.18 RETOTALING

Candidates are permitted to apply for retotaling within 10 days from the date of publication of results. The student should submit request for retotaling in the prescribed format.and pay the fee prescribed per paper.

## 6.19 PHOTOCOPY OF ANSWER SCRIPT

Candidates are permitted to apply for obtaining a photocopy of answer paper within 20 days from the date of publication of results. The student should submit request for photocopy of answer script in the prescribed format.

## 6.20 REVALUATION

Candidates are permitted to apply for revaluation after obtaining a photocopy of answer paper within 30 days from the date of publication of results. The student should submit request for revaluation in the prescribed format and pay the fee prescribed per paper.

## 6.21MALPRACTICE

Any malpractice by the students debars them from subsequent appearance based on the decision of the examination committee. In all cases of malpractice their conduct certificates will indicate malpractice.

## 6.22 EVALUATION AND GRADING SYSTEM

The performance of a student in each paper is evaluated in terms of percentage of marks with a provision for conversion to grade points (GP). Evaluation for each paper shall be done by a continuous internal assessment by the concerned paper teacher as well as by an end semester examination and will be consolidated at the end of the course.

The term grading system indicates a Ten Point Scale of evaluation of the performances of studentsin terms of marks obtained in the Internal and External Examination, grade points and letter grade.

Once the marks of the Internal and end-semester examinations for each of the papers are available, they will be added. The marks thus obtained will then be graded as per details provided in Table.

The sum of total performance in each semester will be rated by Grade Point Average (GPA) while the continuous performance from the second semester onwards will be marked by Cumulative Grade Point Average (CGPA). These two are calculated by the following formulae.

$$GPA = \frac{\text{Sum of [Credits acquired x Grade points]}}{\text{Sum of Credits acquired}}$$

For the calculation of Grade Point Average (GPA), Gi is the grade point awarded; Ci is the credit units earned for the ith paper.

$$CGPA = \frac{\sum_{i=1}^{n} C_i GP_i}{\sum_{i=1}^{n} C_i}$$

where „Ci" is the Credit earned for the paper i in any semester ; „Gi" is the Grade Point obtained by the student for the paper i and „n" is the number of papers passed in that or CGPA = GPA of allthe papers starting from the first semester to the current semester.

Note: The GPA and CGPA shall be calculated separately for the following five parts:

Part I: Core Subject; Part II: Elective Subject, Part III: Skill based subjects, Part IV: Internship and Part V: Certificate course

| Marks | Grade Point | CGPA | Letter Point | Classification of Final Result |
|---|---|---|---|---|
| 96 and above | 10 | 9.51 and above | $S^+$ | First Class with Exemplary |
| 91 – 95 | 9.5 | 9.01 – 9.50 | S | |
| 86 – 90 | 9.0 | 8.51 – 9.00 | $D^{++}$ | First Class with Distinction |
| 81 – 85 | 8.5 | 8.01 – 8.50 | $D^+$ | |
| 76 – 80 | 8.0 | 7.51 – 8.00 | D | |
| 71 – 75 | 7.5 | 7.01 – 7.50 | $A^{++}$ | First Class |
| 66 – 70 | 7.0 | 6.51 – 7.00 | $A^+$ | |
| 61 – 65 | 6.5 | 6.01 – 6.50 | A | |
| 56 – 60 | 6.0 | 5.51 – 6.00 | $B^+$ | Second Class |
| 51 – 55 | 5.5 | 5.01 – 5.50 | B | |
| 46 – 50 | 5.0 | 4.51 – 5.00 | $C^+$ | Third Class |
| 40 – 45 | 4.5 | 4.00 – 4.50 | C | |
| Below 40 | 0 | Below 4.00 | F | Fail |

The grade card / mark sheet issued at the end of the semester to each student will contain thefollowing:

a. the marks obtained for each paper registered in the semester

b. the credits earned for each paper registered for that semester

c. the performance in each paper by the letter grade point obtained

d. the Grade Point Average (GPA) of all the papers registered for that semester and

e. from the second semester onwards, the Cumulative Grade Point Average (CGPA) of all thepapers and

f. the class and grade of the student in the final CGPA

## 6.23 TRANSITORY PROVISION

Candidates who have undergone the course of study prior to the academic year 2015-2016 will be permitted to appear for the examinations under those Regulations for a period of TWO years i.e. upto and inclusive of April - May 2024 Examinations. Thereafter, they will be permitted to appearfor the examination only under the Regulations then in force.

| Core Paper Theory – 1 | | | |
|---|---|---|---|
| Title of the paper withsubject code | **PRINCIPLES OF COMPILER DESIGN** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **4** |
| Paper mainly focuses on | **SKILL DEVELOPMENT** | | |

**COURSE OBJECTIVES:**

- To explore the principles, algorithms, and data structures involved in the design and construction of compilers.
- To learn context-free grammars, lexical analysis, parsing techniques, symbol tables, error recovery, code generation, and code optimization.

**COURSE OUTCOMES:**

**CO-1:** Comprehend the five phases of the compiler design and describe the nitty-gritty of functions of each of the phases.

**CO-2:** Application of Regular Expression and Finite Automata for Lexical analysis of the language to describe the tokens and to recognize the tokens respectively by the compilers.

**CO-3:** Analysis of parsing procedures by compare and contrast of various bottom-up and top-down parsing methods.

**CO-4:** Evaluate the intermediate codes of the compiler and inspect optimization techniques for the intermediate code.

**CO-5:** Synthesize a machine code of a trivial compiler for the design of Identifier token by constructing Regular Expression, Automata, Grammars, building a parser and an optimized intermediate code for the identifier

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | Introduction – Structure of a Compiler – Compiler writing tools – Basic constructs of High-level programming languages – Data structures – Parameter transmission. Lexical Analysis – Role of Lexical analyzer – Finite Automata – Regular Expressions to Finite Automata – Minimizing number of states of Deterministic Finite Automaton – Implementation of Lexical analyzer in C. | 12 | CO-1 | K1, K2 |
| II | Parsing Techniques – Context free Grammars – Derivations and Parse trees – Ambiguity – Capabilities of Context free grammar - Top down and Bottom-up Parsing – Handles – Shift Reduce parsing – Operator precedence parsing – Recursive Descent parsing – Predictive Parsing | 12 | CO-1<br>CO-2 | K3 |

| | | | | |
|---|---|---|---|---|
| III | Automatic Parsing Techniques – LR parser – Canonical Collection of LR(0) items – Construction of SLR parsing tables – LR(1) sets of items construction – Construction of canonical LR parsing tables. | 12 | CO-3 | K4 |
| IV | Syntax Directed Translation – Semantic action – Implementation of syntax directed translators – Intermediate code: Prefix notation, Quadruples, Triples, Indirect triples – Methods of translation of assignment statements, Boolean expressions and Control statements. | 12 | CO-4<br>CO-5 | K5 |
| V | Symbol Tables and Code Generation: Representing information in a symbol table – Data structures for symbol table – Introduction to code optimization – Basic blocks – DAG representation – Peep hole Optimization - Error detection and Recovery – Introduction to Code generation. | 12 | CO-5 | K6 |

**TEXT BOOKS:**

1. Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, "Compilers: Principles, Techniques, and Tools, Pearson Education Asia, 2001
2. Principles of Compiler Design by V Raghavan
3. Principles of Compiler Design by D. Chitra

**REFERENCE BOOKS:**

1. Dhamdhere D.M., "Compiler Construction: Theory and Practice", McMillan India Ltd., 1983 2. Holub Allen, "Compiler Design in C", Prentice Hall of India, 1990
2. Fundamentals of Compiler Design, Adesh k Pandey

| Core Paper Theory – 2 | | | |
|---|---|---|---|
| Title of the paper withsubject code | **PRINCIPLES OF ALGORITHM DESIGN** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **4** |
| Paper mainly focuses on | **SKILL DEVELOPMENT** | | |

**COURSE OBJECTIVES:**

- Analyze the asymptotic performance of algorithms.
- Write rigorous correctness proofs for algorithms.
- Demonstrate a familiarity with major algorithms and data structures.
- Apply important algorithmic design paradigms and methods of analysis.
- Synthesize efficient algorithms in common engineering design situations.

**COURSE OUTCOMES:**

**CO-1:** Understanding of steps in design of algorithms and analysis of time complexity and space complexity using asymptotic notation.

**CO-2:** Describe and differentiate 5 broad types of design methods such as Divide and Conquer, Greedy, Backtracking, Branch and Bound, Dynamic Programming

**CO-3:** Demonstrate knowledge about significance of each of the methods and differentiating various methods in solving specific problems.

**CO-4:** Evaluating the performance of the methods in solving problems using time complexity analysis with asymptotic notation.

**CO-5:** Design an algorithm for travelling salesman problem using 5 methods.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | **INTRODUCTION**: Algorithm, Pseudo code for expressing algorithms, Performance Analysis-Space complexity, Time complexity, Asymptotic Notation- Big oh notation, Omega notation, Theta notation and Little oh notation, Probabilistic analysis, Amortized analysis. | 12 | CO-1 | K2,K3 |
| II | Disjoint Sets- disjoint set operations, union and find algorithms, spanning trees, connected components and biconnected components.<br>**DIVIDE AND CONQUER**: General method, applications - Binary search, Quick sort, Merge sort, Strassen's matrix multiplication. | 12 | CO-1<br>CO-2 | K1 |

| | | | | |
|---|---|---|---|---|
| III | **GREEDY METHOD**: General method, applications-Job sequencing with deadlines, 0/1 knapsack problem, Minimum cost spanning trees, Single source shortest path problem. **DYNAMIC PROGRAMMING**: General method, applications-Matrix chain multiplication, Optimal binary search trees, 0/1 knapsack problem, All pairs shortest path problem, Travelling sales person problem, Reliability design. | 12 | CO-3 | K4 |
| IV | **BACKTRACKING**: General method, applications-n-queen problem, sum of subsets problem, graph coloring, Hamiltonian cycles. **BRANCH AND BOUND:** General method, applications - Travelling sales person problem, 0/1 knapsack problem. | 12 | CO-4 CO-5 | K5 |
| V | **LC BRANCH AND BOUND SOLUTION:** FIFO Branch and Bound solution. NP-Hard and NP-Complete problems: Basic concepts, non-deterministic algorithms, NP - Hard and NP Complete classes, Cook's theorem. | 12 | CO-5 | K6 |

**TEXT BOOKS:**


1. Ellis Horowitz, Sartaj Sahni, S. Rajasekaran, "Fundamentals of Computer Algorithms", Second Edition, University Press, 2008.
2. Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Third Edition, PHI Learning Private Limited, 2012.
3. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.


**REFERENCE BOOKS:**


1. Donald E. Knuth, "The Art of Computer Programming", Volumes 1 & 3 Pearson Education, 2009. 2.
2. Steven S. Skiena, "The Algorithm Design Manual", Second Edition, Springer, 2008

| **Core Paper Theory – 3** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **DISTRIBUTED COMPUTING** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **4** |
| Paper mainly focuses on | **SKILL DEVELOPMENT** | | |

**COURSE OBJECTIVES:**

- To enable students learn the need of distributed computing and its features such as message passing, IPC, synchronization and network requirements.
- To inculcate the concepts of shared memory in distributed environment along with deadlock issues.
- To impart knowledge on distributed filesystem model, atomic transactions and security issues in distributed computing

**COURSE OUTCOMES:**

**CO-1:** Demonstrate knowledge of evolution and designing model of distributed computing

**CO-2:** Analyze and formalize the IPC message passing and synchronization in multi-datagram messages.

**CO-3:** Develop distributed shared memory architecture, design and implementation issues in distributed shared memory.

**CO-4:** Experiment distributed file system, file models and design principles

**CO-5:** Formulate the security issues in distributed computing and cryptography for authentication access control.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNIT |
|---|---|---|---|---|
| I | Fundamentals: What is Distributed Operating System-Evolution of Distributed Computing system –Distributed Computing System models-Why are Distributed Computing Systems gaining popularity-What is a Distributed Computing System-Issues in Designing Distributed Computing System –Introduction to Distributed Computing Environment. Introduction to Computer Networks-Network types-LAN-WAN-Communication protocols- Internetworking-ATM Technology. | 12 | CO-1 | K1, K2 |
| II | Message Passing: Introduction – Desirable features-Issues in IPC Message Passing-Synchronization-Buffering – Multidatagram Messages-Encoding and Decoding-Process Addressing – Failure Handling-Group Communication. | 12 | CO-1<br>CO-2 | K3 |
| III | Distributed Shared Memory: Introduction – General Architecture of DSM system- Design and Implementation Issues of DSM – Granularity-Structure of Shared Memory- Replacement Strategy- | 12 | CO-3 | K4 |

| | | | | |
|---|---|---|---|---|
| | Thrashing-Heterogeneous DSM – Advantages. Synchronization: Introduction Clock Synchronization – Event Ordering –Mutual Exclusion – Deadlock-Election Algorithm. | | | |
| IV | Distributed File System: Introduction-Desirable features- File models-File Accessing Models- File Sharing Semantics – File Caching Schemes – File Replication-Fault Tolerance- Atomic Transactions-Design Principles. | 12 | CO-4 | K4, K5 |
| V | Security: Introduction – Potential Attacks to Computer system – Cryptography- Authentication Access Control- Digital Signatures – Design Principles. | 12 | CO-5 | K5, K6 |

**TEXT BOOKS:**


1. A.S. Tanenbaum - Modern Operating Systems - Prentice Hall.
2. Sunita Mahajan and Seema shah, "Distributed computing", Oxford, Second edition.
3. Andrew S. Tanenbaum & Maarten van steen, "Distributed systems: Principle andparadigms", Prentice Hall of India Pvt. Ltd.


**REFERENCE BOOKS:**


1. James Martin, "Computer Networks and Distributed Processing, Software Techniquesand Architectures", Pearson Education.
2. Garg, Vijay K. *Elements of distributed computing*. John Wiley & Sons, 2002.
3. Garrido, José M., and Richard Schlesinger. *Principles of modern operating systems*.Jones & Bartlett Learning, 2008.


**WEBREFERENCES**:

1.http://www.darshan.ac.in/Upload/DIET/Documents/CE/2160710_Distributed_ Operating_System_GTU_Study_Material_2017_22042017_033831AM.pdf

2. http://www.coda.cs.cmu.edu/ljpaper/lj.html

3.http://www.windowsnetworking.com/articles_tutorials/Windows2003-Distributed-File-ystem.html

| **Core Paper Theory – 4** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **MICROSERVICES ARCHITECTURE** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **4** |
| Paper mainly focuses on | **EMPLOYABILITY** | | |

**COURSE OBJECTIVES:**

- To inculcate higher-end knowledge in the Java script language.
- To explore the web applications using Express, REST API along with other features of Node.js
- To impart knowledge about the life cycle of microservices using Node.js

**COURSE OUTCOMES:**

**CO-1:** Demonstrate knowledge of client-side and server Java script features such as Datatypes, operators, methods, branching and looping constructs, classes and objects.

**CO-2:** Analyze and formalize the browser object model DOM, Event handling and cookies.

**CO-3:** Develop knowledge in node.JS Asynchronous programming. JSON Server, Asynchronous Loops in modules.

**CO-4:** Experiment web applications with Express, REST APIs and MongoDB.

**CO-5:** Formulate the design issues with Microservices using node.js.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | **JavaScript – I:** Introduction- Introduction to Web Development , Client-Side and Server-Side JavaScript, Origin, History and Evolution of JavaScript, Features of JavaScript , Structure of Browsers, Saying *Hello World* to JS , Placement of Code, - Building the Basics - Character Set , Variables , Data Types , Operators , Control Flow Statements - Objects- Properties, Creating Objects , Objects as Record and Dictionary , Operations on Objects, Prototypal Inheritance , Classes , Garbage Collection - Functions - Variable Scope , Declaration , Parameters- Arrays – Properties , Declaration, Accessing an Array , Built-In Methods, Nesting and Multidimensional Arrays | 12 | CO-1 | K1, K2 |
| II | **JavaScript – II:** Browser Object Model- Window, History, Navigator, Location, Screen, Document Object -Document Object Model- Relationship, DOM Tree and Nodes, Document Object, Elements, Accessing Elements, Event Handling- Standard Built-In Objects- Fundamental Objects , Error Objects , Number and Dates , Text or String | 12 | CO-2 | K2, K3 |

| | | | | |
|---|---|---|---|---|
| | Processing , Keyed Collections , Indexed Collections , Structured Data ,Value Properties, Function Properties - Validation- Error Handling-Error Handling and Cookies | | | |
| III | **node.js – I**; Introduction- Why Node.js?, What Exactly Is Node.js? - Getting Started- Installing, Running, First Web Server, Debugging - Asynchronous Programming- The Old Way of Doing Things, The Node.js Way of Doing Things, Error Handling and Asynchronous Functions, Maintaining a Sense of Identity, Being Polite—Learning to Give Up Control, Synchronous Function Calls - Writing Simple Applications- First JSON Server, Node Pattern: Asynchronous Loops, Learning to Juggle, More on the Request and Response Objects, Increased Flexibility, Modifying Things – Modules- Writing Simple Modules, Consuming Modules, Writing Modules | 12 | CO-3 | K4 |
| IV | **node.js – II:** Expanding Web Server- Serving Static Content, Assembling Content - Building Web Applications with Express- Installing Express, Routing and Layers, REST API, Additional Middleware Functionality- Databases I: NoSQL- Structuring Your Data for MongoDB, Understanding the Basic Operations - Databases II: SQL (MySQL) - Getting Ready, Basic Database Operations | 12 | CO-4 | K5 |
| V | **Microservices using node.js:** Developing Microservices- Designing Microservice Endpoints, Implementing the Data for a Microservice, Implementing Code for a Microservice - Releasing Microservices- Setting Up the Staging Environment, Deploying | 12 | CO-5 | K6 |

**TEXT BOOKS:**

1. JavaScript Syntax and Practices, Dr Ravi Tomar & Ms Sarishma Dangi, CRC Press, 2022
2. Learning Node.js, A Hands-On Guide to Building Web Applications in JavaScript, Marc Wandschneider, Pearson Education, 2013
3. Microservices: Up and Running *A Step-by-Step Guide to Building Microservices Architecture, O'Reilly Media,* Ronnie Mitra and Irakli Nadareishvili, 2020

**REFERENCE BOOKS:**

1. Microservice Architecture: Aligning Principles, Practices, and Culture, Irakli Nadareishvili, Matt McLarty, Ronnie Mitra, Michael Amundsen
2. Monolith to Microservices: Evolutionary Patterns to Transform Your Monolith, Book by Sam Newman

| **Core Paper Practical – 1** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **MICROSERVICES ARCHITECTURE LAB** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **2** |
| Paper mainly focuses on | **EMPLOYABILITY** | | |

**COURSE OBJECTIVES:**

- To inculcate practical knowledge in the Java script language.
- To explore the web applications connecting Express, REST API along with other features of Node.js
- To device programs for creating microservices using Node.js

**COURSE OUTCOMES:**

**CO-1:** Demonstrate knowledge of client-side and server Java script features such as Datatypes, operators, methods, branching and looping constructs, classes and objects.

**CO-2:** Analyze and formalize the browser object model DOM, Event handling and cookies.

**CO-3:** Develop knowledge in node.JS Asynchronous programming. JSON Server, Asynchronous Loops in modules.

**CO-4:** Experiment web applications with Express, REST APIs and MongoDB.

**CO-5:** Formulate the design issues with Microservices using node.js.

| **UNIT NO.** | **SYLLABUS** | **COs** | **COGNITIVE LEVEL** |
|---|---|---|---|
| 1 | Write a program to iterate over the object's properties, and display them on the console | CO-1<br>CO-2<br>CO-3<br>CO-4<br>CO-5 | K1,K2,K3<br>K4,K5,K6 |
| 2 | Write a program for creating objects with different methods and using getter/setter methods | | |
| 3 | Write a program for creating objects with user-defined Object Constructor and some action on it | | |
| 4 | Write a program for demonstrating length property, bind, call, apply and to String methods & closure | | |
| 5 | Write a program for CRUD actions on an array (Create, Read, Update, Delete) | | |

| | | | |
|---|---|---|---|
| 6 | Write a program for traversing forward/backward through browser session history. Use *window* and other objects to manipulate the web page | | |
| 7 | Write a program for basic operations on DOM | | |
| 8 | Write a program for reacting to events on a web page | | |
| 9 | Write a program for event delegation model | | |
| 10 | Write a program for counting the number of selected items in a form | | |
| 11 | Write a program for storing form details into cookies upon successful validation | | |
| 12 | Write a program for synchronous and asynchronous functions | | |
| 13 | Write a program for returning a JSON string | | |
| 14 | Write a program for returning folders | | |
| 15 | Write a program for demonstrating GET method | | |
| 16 | Write a program for demonstrating POST method | | |
| 17 | Write and publish your own modules | | |
| 18 | Write a program for serving static content | | |
| 19 | Build a simple web application by using Express | | |
| 20 | Build a simple web application to connect to mongoDB | | |
| 21 | Build a simple web application to connect to mySQL | | |
| 22 | Write a simple REST API | | |
| 23 | Develop conversion services like currency, temperature, physical units, etc | | |

| **Core Paper Practical – 2** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **PRINCIPLES OF ALGORITHMS DESIGN USING JAVA LAB** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **2** |
| Paper mainly focuses on | **EMPLOYABILITY** | | |

**COURSE OBJECTIVES:**

- Analyze the asymptotic performance of algorithms.
- Write rigorous correctness proofs for algorithms.
- Demonstrate a familiarity with major algorithms and data structures.
- Apply important algorithmic design paradigms and methods of analysis.
- Synthesize efficient algorithms in common engineering design situations.

**COURSE OUTCOMES:**

**CO-1:** Understanding of practical program using Divide and conquer method to solve merge sort, quick sort and finding maximum and minimum of numbers.

**CO-2:** Device programs for Knapsack Problem, Tree vertex splitting and Job Sequencing using Greedy method.

**CO-3:** Demonstrate practical knowledge in writing programs for Multistage graphs, All Pairs Shortest Paths, String Editing, BFS and DFS using dynamic programming method.

**CO-4:** Evaluate the performance of programs for 8-queens problem and Hamiltonian cycles using Backtracking method.

**CO-5:** Design an algorithm for travelling salesman problem using 5 methods.

| **UNIT NO.** | **SYLLABUS** | **COs** | **COGNITIVE LEVEL** |
|---|---|---|---|
| 1 | Divide and Conquer:<br>a. Merge Sort<br>**b.** Quick Sort<br>**c. Maximum and Minimum** | CO-1<br>CO-2<br>CO-3<br>CO-4<br>CO-5 | K1,K2,K3<br>K4,K5,K6 |
| 2 | Greedy Method:<br>a. Knapsack Problem<br>b.Tree vertex splitting<br>c. Job Sequencing | | |
| 3 | Dynamic Programming :<br>a. Multistage graphs<br>b. All Pairs Shortest Paths<br>c. String Editing,<br>d. BFS and DFS. | | |
| 4 | Back Tracking :<br>a. 8 Queen Problems<br>b. Hamiltonian Cycles. | | |

| Extra Disciplinary Paper Theory – 1 | | | |
|---|---|---|---|
| Title of the paper withsubject code | **THEORY OF COMPUTATION** | | |
| Category of the course | Year | Semester | Credits |
| **Extra Disciplinary** | **I** | **II** | **5** |
| Paper mainly focuses on | **SKILL DEVELOPMENT** | | |

**COURSE OBJECTIVES:**

- To understand formal languages and finite automata.
- To understand conversion of regular expression to Finite Automata.
- To understand context free grammars and pushdown automata.
- To investigate the problems that cannot be solved by computers.

**COURSE OUTCOMES:**

**CO-1:** Describe foundations for computation and conversion steps for regular expression, finite automata and grammars.

**CO-2:** Analyze the types of Grammars, concentrate on Regular languages and Context Free grammars and its properties.

**CO-3:** Apply the pumping lemma for validating regular language and context free language and demonstrate algorithms for conversion between languages.

**CO-4:** Evaluate linear automata and push-down automata for a given regular language and context free language.

**CO-5:** Produce simple programs for a Turing Machine and List examples of undecidable problems

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | **FINITE AUTOMATA (FA)**: Introduction, Deterministic Finite Automata (DFA) -Formal definition, simpler notations (state transition diagram, transition table), language of a DFA. Nondeterministic Finite Automata (NFA)- Definition of NFA, language of an NFA, Equivalence of Deterministic and Nondeterministic Finite Automata, Applications of Finite Automata, Finite Automata with Epsilon Transitions, Eliminating Epsilon transitions, Minimization of Deterministic Finite Automata, Finite automata with output (Moore and Mealy machines) and Inter conversion. | 12 | CO-1 | K1, K2 |
| II | **REGULAR EXPRESSIONS (RE):** Introduction, Identities of Regular Expressions, Finite Automata and Regular Expressions- Converting from DFA's to Regular Expressions, Converting Regular Expressions to Automata, | 12 | CO-1<br>CO-2 | K3 |

| | | | | |
|---|---|---|---|---|
| | applications of Regular Expressions. REGULAR GRAMMARS: Definition, regular grammars and FA, FA for regular grammar, Regular grammar for FA. Proving languages to be non-regular -Pumping lemma, applications, Closure properties of regular languages. | | | |
| III | **CONTEXT FREE GRAMMER (CFG):** Derivation Trees, Sentential Forms, Rightmost and Leftmost derivations of Strings. Ambiguity in CFG's, Minimization of CFG's, CNF, GNF, Pumping Lemma for CFL's, Enumeration of Properties of CFL ( Proof's omitted ). | 12 | CO-3 | K4 |
| IV | **PUSHDOWN AUTOMATA:** Definition, Model, Acceptance of CFL, Acceptance by Final State and Acceptance by Empty stack and its Equivalence, Equivalence of CFG and PDA. TURING MACHINES ™: Formal definition and behaviour, Languages of a TM, TM as accepters, and TM as a computer of integer functions, Types of TMs. | 12 | CO-4<br>CO-5 | K5, K6 |
| V | **RECURSIVE AND RECURSIVELY ENUMERABLE LANGUAGES (REL):** Properties of recursive and recursively enumerable languages, Universal Turing machine, The Halting problem, Undecidable problems about TMs. Context sensitive language and linear bounded automata (LBA), Chomsky hierarchy, Decidability, Post's correspondence problem (PCP), undecidability of PCP. | 12 | CO-5 | K5, K6 |

**TEXT BOOKS:**

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman (2007), Introduction to Automata Theory Languages and Computation, 3rdedition, Pearson Education, India.
2. Elements of the Theory of Computation Book by Christos Ch Papadēmētriou and Harry R. Lewis
3. An Introduction to Formal Languages and Automata Book by Peter Linz

**REFERENCE BOOKS:**

1. K. L. P Mishra, N. Chandrashekaran (2003), Theory of Computer Science-Automata Languages and Computation, 2nd edition, Prentice Hall of India, India.
2. Introduction to Languages and the Theory of Computation Book by John C. Martin

| **Core Paper Theory – 5** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **DIGITAL IMAGE PROCESSING** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **II** | **4** |
| Paper mainly focuses on | **EMPLOYABILITY** | | |

**COURSE OBJECTIVES:**

- Provide the student with the fundamentals of digital image processing.
- Give the students a taste of the applications of the theories taught in the subject. This will be achieved through some selected lab sessions.
- Introduce the students to some advanced topics in digital image processing.
- Give the students a useful skill base that would allow them to carry out further study should they be interested and to work in the field.

**COURSE OUTCOMES:**

**CO-1:** Understand the concepts of Image sensing steps and Image representation for analog and Digital Image.

**CO-2:** Apply Image processing techniques for noise removal and image enhancement from Digital Image.

**CO-3:** Analyze Image transformation techniques for analog and digital image.

**CO-4:** Evaluate Image compression models such as Huffman coding, JPEG, etc. for a given Digital Image.

**CO-5:** Design a Fourier Transform model to convert an analog image to a digital image.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | Introduction – The origin - Fundamental steps components - Image Sampling and Quantization – Some basic relationship between pixels – Linear and nonlinear operations. Image Enhancement in spatial domain – Some Basic Gray level transformation – Histogram processing- Enhancement using Arithmetic Logic operations – Basics of spatial filtering – smoothing – sharpening – Image Enhancement in frequency domain. | 12 | CO-1 | K1, K2 |
| II | Color Image processing – color models – pseudo color Image processing – Smoothing – Sharpening – Color transformation - Color segmentation. | 12 | CO-2 | K2, K3 |
| III | Wavelets – Multiresolution Processing – Image compression models – Lossy compression – Image Compression standards. | 12 | CO-3 | K4 |
| IV | Image segmentation – Edge Linking – Boundary Detection – | 12 | CO-4 | K5 |

| | | | | |
|---|---|---|---|---|
| | Thresholding – Region Based segmentation by morphological watersheds. | | CO-5 | |
| V | Morphological Image Processing: Erosion and Dilation, Opening and Closing, The Hit-Or- Miss Transformation, Basic Morphological Algorithms, Gray-Scale Morphology. Object Recognition: Patterns and Pattern Classes, Recognition Based on Decision-Theoretic Methods, Structural Methods. | 12 | CO-5 | K5, K6 |

**TEXT BOOKS:**

1. R. C. Gonzalez and R. E. Woods, Digital image processing, 3/e , PH, 2007.
2. Digital Image Processing by S Sridhar
3. Digital Image Processing by Jayaraman S, Veerakumar T, Esakkirajan S

**REFERENCE BOOKS:**

1. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson, 1989.
2. Digital Image Processing by Kenneth R Castleman, Pearson Education

| **Core Paper Theory – 6** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **UNIX AND PERL PROGRAMMING** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **II** | **4** |
| Paper mainly focuses on | **EMPLOYABILIBY** | | |

**COURSE OBJECTIVES:**

- Written technical communication and effective use of concepts and terminology.
- Facility with UNIX command syntax and semantics.
- Ability to read and understand specifications, scripts and programs.
- Individual capability in problem solving using the tools presented within the class
- Students will demonstrate a mastery of Perl Programming and scripting methods.

**COURSE OUTCOMES:**

**CO-1:** Understand all the UNIX utilities, the basic UNIX process structure and the UNIX file system

**CO-2:** Articulate simple UNIX filters, UNIX pipes and redirection, UNIX environment, traps, signals, and Regular Expressions.

**CO-3:** Deduce least one Shell scripting language and Classify system calls in UNIX

**CO-4:** Review the concepts of process, threads, and file structure,

**CO-5:** Compose a Shell scripting for creating an application with Inter process Communication using pipes, shared memory, semaphores and messages.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | Understanding Unix –commands, locating, internal and external, arguments, options , flexibility– General purpose utilities-banner, cal, date, calendar, who, tty, etc – Navigating the file system-the file, what is in it, parent-child, pwd, home, absolute path, cd, mkdir, rmdir, ls, etc | 12 | CO-1 | K1, K2 |
| II | ordinary files – cat, cp, rm, mv, more, lp, file, wc, od, split, cmp, etc-The shell-sh, pattern matching, escaping, quoting, redirection, special files, pipes, tees, command substitution, shell variables, korn, bash and c shells – The environment-system variables, .profile, stty, PWD, aliases, command history, command editing, set options, miscellaneous features. | 12 | CO-2 | K2, K3 |
| III | Basic file attributes –-l, -d, file permissions, chmod - simple filters-sample database, pr, head, tail, cut, paste, sort, uniq, nl, tr – regular expressions and grep-grep, regular | 12 | CO-3 | K3 |

| | | | | |
|---|---|---|---|---|
| | expressions, egrep, fgrep | | | |
| IV | The process-sh, parents and children, ps, system process, mechanism, internal and external commands, jobs in background, kill, nice, job control, at and batch, cron- shell programming-scripts, read, command line arguments, exit status, operators, exit, if,case, expr, ksh, sleep and wait, while, until, for, redirection, here document, set, trap – more file filters – file systems, inode, chown, chgrp, listing, ln, the directory , the device | 12 | CO-4<br>CO-5 | K5, K6 |
| V | System administration I –root, privileges, operation, managing disk spaces, find, dd, backups, cpio, tar– advanced filters-sed, line addressing, inserting and changing, context, selected lines, -f, substitution, properties of regular expressions, awk, spilitting a line, printf, operators, number processing, BEGIN and END, positional parameters, getline, built-in variables, arrays, functions, interface with the shell, control flow - PERL-starting, chop, interpreter, variables and operators, command line, current line and number, lists, arrays, associative arrays, regular expressions and substitution, file handling, file tests, subroutines, printing | 12 | CO-5 | K6 |

**TEXT BOOKS:**

1. UNIX : Concepts and Applications, Sumitabha Das, 4th Edition, TMH
2. Learning Perl, *Randal L. Schwartz, brian d foy, and Tom Phoenix, 8th Edition, 2021*
3. *The UNIX Programming Environment*, Kernighan, Brian W., Pike, Rob, Prentice-Hall, 1984
4.

**REFERENCES BOOKS:**

1. UNIX : The Textbook, Robert M. Koretsky, , Chapman and Hall/CRC; 3rd edition, 2016
2. Beginning Perl, Curtis "Ovid" Poe , Wiley, 2012

| Elective Paper Theory – I | | | |
|---|---|---|---|
| Title of the paper withsubject code | **ETHICAL HACKING** | | |
| Category of the course | Year | Semester | Credits |
| **Elective** | **I** | **II** | **3** |
| Paper mainly focuses on | **EMPLOYABILITY** | | |

**COURSE OBJECTIVES:**

- To enable students learn a secure platform for computers and users, free from disruptions and invasions from unauthorized users and programs.
- To introduce students about various testing internal systems, searching for security breaches, finding weak points and training other developers in security analysis
- To provide application of security tools to test network and systems security.

**COURSE OUTCOMES:**

**CO-1:** Understand the concepts of Ethical Hacking, Enterprise Information security Architecture.

**CO-2:** Discuss various forms of foot printing, Network scanning and protocols and techniques in HTTP Tunneling and IP Spoofing.

**CO-3:** Discuss how system hacking works and steganography applications and detection tools.

**CO-4:** Review various Malware threats and its countermeasures and Malware analysis

**CO-5:** Review various case study tools, techniques and counter measures for sniffing attacks and session hijacking.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | **INTRODUCTION TO ETHICAL HACKING**: Information security overview – skills of an ethical hacker – Hacking concepts and phases - Types of attacks – Information Security threats, attack vectors, and controls – Information Assurance (IA) – Information Security Laws and Standards – Security Policies types, HR/legal implications – Physical Security – Threat Modelling – Enterprise Information Security Architecture (EISA) – Network Security Zoning. | 12 | CO-1 | K1 |
| II | **FOOT PRINTING & RECONNAISSANCE:** Foot printing concepts, threats, attack vectors and controls, Foot printing through Search Engines, Foot Printing through Social Networking sites, Website Foot printing, Competitive Intelligence, WHOIS Foot printing, Foot Printing tools. | 12 | CO-2 | K1,K2 |

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|---|---|---|---|---|
| | Scanning Networks: Scanning Methodology, techniques, and countermeasures - Techniques for IDS evasion, scanning, HTTP tunneling, and IP spoofing | | | |
| III | **SYSTEM HACKING**: Cracking passwords, escalating privileges, executing applications, hiding files and covering tracks – Steganography application and classification, tools, methods/attacks on Steganography, Steganography detection tools. | 12 | CO-3 | K3, K4 |
| IV | **MALWARE THREATS**: Introduction to malware – Trojans attacks, how to infect a system, crypters, how to deploy, latest types, analysis, countermeasures - Viruses— stages, types, latest virus maker, analysis, countermeasures - Worms— types, makers, analysis, countermeasures - Malware analysis - Antivirus tools - Penetration testing. | 12 | CO-4 | K4, K5 |
| V | **SNIFFING**: Attacks: MAC, DHCP, and spoofing - Poisoning: ARP and DNS – Tools Social Engineering: Concepts, techniques, impersonation, identity theft, and Counter measures - Phases of an attack - Common targets of an attack -Impersonation scenario - Computer based, mobile based, social networking-based Denial of Service: Concepts, case study, tools, attack techniques, and Countermeasures Botnet - Scanning methods for vulnerable machines - Detection Techniques and tools. Session Hijacking: Concepts, case study, tools, attack techniques, and Countermeasures - Five stages of a web malware attack - Application level session hijacking - Network level session hijacking - TCP/IP Hijacking. | 12 | CO-5 | K5, K6 |

**TEXT BOOKS:**

1. Kimberly Graves, CEH: Certified Ethical Hacker Study Guide, Wiley; 2010.
2. Ethical Hacking and Penetration Testing Guide by Rafay Baloch
3. The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy by Patrick Engebretson

**REFERENCE BOOKS:**

1. Hacking: The Art of Exploitation by Jon Erickson
2. The Web Application Hacker's Handbook: Discovering and Exploiting Security Flaws by Dafydd Stuttard and Marcus Pinto

| **Elective Paper Theory – I** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **DATA MINING** | | |
| Category of the course | Year | Semester | Credits |
| **Elective** | **I** | **II** | **3** |
| Paper mainly focuses on | **EMPLOYABILITY** | | |

**COURSE OBJECTIVES:**

- To motivate, define and characterize data mining as process and data mining applications.
- To Understand Data mining principles and techniques and Introduce DM as a cutting-edge business intelligence
- To identify Business applications and Trends of Data mining

**COURSE OUTCOMES:**

**CO-1:** Understanding the data mining concepts and different types of data warehouse such as Relational, Transactional, Object oriented, spatio-temporal, multimedia databases.

**CO-2:** Comprehend the data preprocessing techniques such as data reduction, data integration, data transformation, data reduction and discretization.

**CO-3:** Analyze various data mining techniques such as association rule mining, Multilevel, Multidimensional, and Constraint Based Association Mining and implement Apriori algorithm.

**CO-4:** Compare and contrast the classification and prediction techniques such as Tree induction, Bayesian Classification and Back Propagation.

**CO-5:** Review various Clustering Methods such as Hierarchical Methods, Density Based Methods, Web Mining, Spatial Mining and Temporal Mining.

| **UNIT NO.** | **SYLLABUS** | **HOURS** | **COs** | **COGNITIVE LEVEL** |
|---|---|---|---|---|
| I | **INTRODUCTION TO DATA MINING**: Motivation - On what kind of data - Data Mining Functionalities - Classification of Data Mining systems - Major Issues in Data Mining systems. Data Preprocessing – Data cleaning - Data Integration and Transformation - Data Reduction - Discretization and concept Hierarchy Generation. | 12 | CO-1 | K1, K2 |
| II | **MINING ASSOCIATION RULES IN LARGE DATABASES**: Association Rule Mining - Mining Single Dimensional Boolean Association rules from Transactional Databases - Mining Multilevel Association Rules – Mining Multidimensional Association Rules - From Association Mining to Correlation Analysis - Constraint- Based Association Mining. | 12 | CO-1<br>CO-2 | K3 |

| | | | | |
|---|---|---|---|---|
| III | **CLASSIFICATION AND PREDICTION**: What is Classification and Prediction - Issues regarding Classification and Prediction - Classification by Decision Tree Induction - Bayesian Classification - Classification by Back propagation - Other Classification Methods - Prediction - Classifier Accuracy. | 12 | CO-3 | K4, K5 |
| IV | **CLUSTER ANALYSIS**: What is Cluster Analysis? Types of Data in Cluster Analysis - A Categorization of Major Clustering Methods - Partitioning Methods - Hierarchical Methods - Density-Based Methods - Grid-Based Methods - Outlier Analysis. | 12 | CO-4<br>CO-5 | K5 |
| V | **APPLICATIONS AND TRENDS IN DATA MINING**: Data Mining Applications - Data Mining System Products and Research Prototypes - Additional Themes on Data Mining - Social Impacts of Data Mining - Trends in Data Mining. | 12 | CO-5 | K6 |

**TEXT BOOKS:**


1.HanJiawei Han and Kamber Micheline, "Data Mining Concepts and Techniques", Morgan Kaufmann Publishers, Second Edition,2006.

2. Data Mining: Concepts Models Methods And Algorithms by Mehmed Kantardzic, WILEY INDIA

3. Data Mining and Data Warehousing: Principles and Practical Techniques


**REFERENCE BOOKS:**


1. M Barry and G.Linoff ", Mastering Data Mining", John Wiiley, Second Edition

2. Dunham H. Margaret ,"Data Mining- Introductory and advanced topics", Pearson Education,

| **Elective Paper Theory – I** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **INTERNET-OF-THINGS** | | |
| Category of the course | Year | Semester | Credits |
| **Elective** | **I** | **II** | **3** |
| Paper mainly focuses on | **EMPLOYABILITY** | | |

**COURSE OBJECTIVES**:

- To understand the concepts of Internet of Things and the application of IoT.
- To Determine the Market perspective of IoT.
- To Understand the vision of IoT from a global context

**COURSE OUTCOMES:**

**CO-1:** Understanding the diverse fields where IoT is being used and wider range of IoT-applications

**CO-2:** Comprehend how M2M value chains are converted to IoT value chains

**CO-3:** Analyze IoT architecture, reference model and different types of views in IoT model.

**CO-4:** Deduce how IoT can be applied to factories, Retail Industry, Business models and other smart applications.

**CO-5:** Review various Governance policies in privacy and security issues.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | IoT & Web Technology, The Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics. | 12 | CO-1 | K1, K2 |
| II | M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. | 12 | CO-1<br>CO-2 | K2, K3 |

| | | | | |
|---|---|---|---|---|
| III | IoT Architecture -State of the Art – Introduction, State of the art, Architecture. Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. | 12 | CO-3 | K4 |
| IV | IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas-Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth. | 12 | CO-4<br>CO-5 | K5 |
| V | Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security | 12 | CO-5 | K6 |

**TEXT BOOKS:**


1. Vijay Madisetti and ArshdeepBahga, "*Internet of Things: (A Hands-on Approach)*", Universities Press (INDIA) Private Limited 2014, 1st Edition.
2. Michael Miller, "*The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart*
3. *Cities Are Changing the World*", Pearson Education 2015.
4. Francis da Costa, "*Rethinking the Internet of Things: A Scalable Approach to Connecting Everything*", Apress Publications 2013, 1st Edition.


**REFERENCE BOOKS:**


1. Waltenegus Dargie, Christian Poellabauer, "*Fundamentals of Wireless Sensor Networks: Theory and Practice*", Wiley 2014.
2. CunoPfister, "*Getting Started with the Internet of Things*", O"Reilly Media 2011.


**WEB REFERENCES:**

- https://github.com/connectIOT/iottoolkit
- https://www.arduino.cc/
- http://www.zettajs.org/

| **Core Paper Practical – 3** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **DIGITAL IMAGE PROCESSING USING PYTHON LAB** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **II** | **2** |
| Paper mainly focuses on | **EMPLOYABILITY** | | |

**COURSE OBJECTIVES:**

- Provide the student with the fundamentals of digital image processing.
- Give the students a taste of the applications of the theories taught in the subject. This will be achieved through some selected lab sessions.

**COURSE OUTCOMES:**

**CO-1:** Understand the Practical python programs of Image representation for analog and Digital Image.

**CO-2:** Apply Image processing techniques in python for noise removal and image enhancement from Digital Image.

**CO-3:** Analyze python programs for Image transformation techniques for analog and digital image.

**CO-4:** Evaluate Image compression models such as Huffman coding.

**CO-5:** Design a Fourier Transform model to convert an analog image to a digital image.

| **UNIT NO.** | **SYLLABUS** | **COs** | **COGNITIVE LEVEL** |
|---|---|---|---|
| 1 | Basic image manipulation (reading, writing, quantization, sub sampling) Using Python | CO-1 CO-2 CO-3 CO-4 CO-5 | K1,K2,K3 K4,K5,K6 |
| 2 | Basic Intensity transformation Using Python | | |
| 3 | Histogram Processing Using Python | | |
| 4 | Filtering in spatial domain-2D FFT and smoothing filters Using Python | | |
| 5 | Image coding using transformations with SPIHT algorithm Using Python | | |
| 6 | Color image Enhancement with spatial sharpening Using Python. | | |

| **Core Paper Practical – 4** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **UNIX AND PERL PROGRAMMING LAB** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **II** | **2** |
| Paper mainly focuses on | **EMPLOYABILITY** | | |

**COURSE OBJECTIVES:**

- Facilitate with UNIX command syntax and semantics.
- Ability to read and understand specifications, scripts and programs.
- Students will demonstrate a mastery of Perl Programming and scripting methods.

**COURSE OUTCOMES:**

**CO-1:** Understand all the UNIX utilities, the basic UNIX process structure and the UNIX file system

**CO-2:** Articulate simple UNIX filters, UNIX pipes and redirection, UNIX environment, traps, signals, and Regular Expressions.

**CO-3:** Deduce least one Shell scripting language and Classify system calls in UNIX

**CO-4:** Review the concepts of process, threads, and file structure,

**CO-5:** Compose a Shell scripting for creating an application with Inter process Communication using pipes, shared memory, semaphores and messages.

| **UNIT NO.** | **SYLLABUS** | **COs** | **COGNITIVE LEVEL** |
|---|---|---|---|
| 1 | Inter Process Communication (IPC) using Message Queues. | CO-1<br>CO-2<br>CO-3<br>CO-4<br>CO-5 | K1,K2,K3<br>K4,K5,K6 |
| 2 | IPC using pipes. | | |
| 3 | Implementation of wait and signal using counting semaphores. | | |
| 4 | Implementation of wait and signal using binary semaphores. | | |
| 5 | Atomic Counter update problem. | | |
| 6 | Counting Semaphores at the user level using binary semaphores. | | |
| 7 | Signaling processes. | | |
| 8 | Deadlock detection (for processes passing messages) | | |
| 9 | Process Scheduling: FCFS | | |

| | | | |
|---|---|---|---|
| 10 | Process Scheduling: Least Frequently Used. | | |
| 11 | Process Scheduling:Round Robin. | | |
| 12 | Producer-Consumer problem with limited buffers. | | |
| 13 | Dining-Philosopher Problem. | | |
| 14 | Reader-Writer problem. | | |
| 15 | Two Process Mutual Exclusion. | | |

| **Core Paper Theory – 7** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **COMMUNICATION NETWORK AND WIRELESS TECHNOLOGY** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **II** | **III** | **4** |
| Paper mainly focuses on | **EMPLOYABILITY** | | |

**COURSE OBJECTIVES:**

- Introduction to planning and design of wireless networks
- Introduction to cellular network and its applications.
- To study advanced technologies like Wireless LAN, WIFI.
- Understanding the wireless sensor network architecture and the protocol stack.

**COURSE OUTCOMES:**

**CO-1:** Comprehend the communication network topologies, network switching types, OSI model.

**CO-2:** Understand the cellular network architecture and its evolution from first generation to third generation CDMA.

**CO-3:** Understand various types of Modulation technique such as ASK, FSK, PSK, QAM and PCM.

**CO-4:** Apply the knowledge in Wireless LANs along with the transmission techniques and IEEE 802 Architecture for wireless LAN.

**CO-5:** Design own Wireless networks using various WI-FI IEEE standards.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | **BASICS OF COMMUNICATION NETWORK:** Introduction – Transmission Fundamentals: Signals, Analog and Digital Data Transmission, Channel Capacity, Transmission Media, Multiplexing – Communication Network: LAN, MAN and WAN, Switching Techniques – Circuit and Packet Switching, Asynchronous Transfer Mode – Protocols and TCP/IP Suite: TCP/IP Protocol Architecture, OSI Model, Internetworking. | 12 | CO-1 | K1,K2 |
| II | **CELLULAR NETWORK:** Cellular Network Architecture - Principles of Cellular Network – First Generation Analog – Second Generation TDMA – Third Generation CDMA – Antennas and Wave Propagation: Antennas, Propagation Modes, Line-of-Sight Transmission – Multipath Fading Environments. | 12 | CO-2 | K3 |
| III | **MODULATION TECHNIQUE:** Signal Encoding Criteria – Digital data, Analog Signals: Performance of ASK, FSK, PSK, Minimum Shift Keying and QAM – Analog Data, | 12 | CO-3 | K4 |

| | | | | |
|---|---|---|---|---|
| | Analog Signals: AM and Angle Modulation – Analog Data, Digital Signals: Performance, PCM and DM – Spread Spectrum –Frequency Hopping Spread Spectrum. | | | |
| IV | **WIRELESS LAN:** Wireless LAN – Overview: Application, Requirements - Infrared LANs: –Strength and Weaknesses, Transmission Techniques – Spread Spectrum LANs – Configuration and Transmission Issues – IEEE 802 Architecture: Protocol Architecture, MAC Frame Format, Logical Link Control. | 12 | CO-4<br>CO-5 | K5 |
| V | **WI-FI AND IEEE 802.11 WIRELESS LAN STANDARD:** IEEE 802.11: Wi-Fi Alliance, IEEE 802.11 Architecture, IEEE 802.11 Services – IEEE 802.11 Medium Access Control: Reliable Data Delivery, Medium Access Control, MAC Frame – IEEE 802.11 Physical Layer - IEEE 802.11a/b/g Standards – Other IEEE 802.11 Standards. | 12 | CO-5 | K6 |

**TEXT BOOKS:**


1. William Stallings. 2009, "Wireless Communications and Networks", Second Edition, Pearson Education, Inc.
2. Vijay K. Garg. 2010, "Wireless Communications and Networking", Elsevier Science.
3. Wireless Communications and Networking Vijay K. Garg.


**REFERENCE BOOKS:**


1. Andrea Goldsmith. 2005, "Wireless Communications", Cambridge University Press.
2. Andreas F. Molisch. 2005, "Wireless Communications", IEEE Press, Wiley Ltd. Publication.

| **Extra Disciplinary Paper Theory – 2** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **OBJECT ORIENTED ANALYSIS AND DESIGN** | | |
| Category of the course | Year | Semester | Credits |
| **Extra Disciplinary** | **II** | **III** | **3** |
| Paper mainly focuses on | **SKILL DEVELOPMENT** | | |

**COURSE OBJECTIVES:**

- To understand the role of objects in software process models
- To analyze the importance of use cases
- To model the system using standard design diagrams
- To design and manage object-based systems
- To study standard OO patterns and their impact on testing

**COURSE OUTCOMES:**

**CO-1:** Recall the object-oriented concepts for analysis and design of systems and gather functional requirements.

**CO-2:** Analyze the real-world problems using the use case diagrams.

**CO-3:** Apply knowledge of OOPs concepts in Object Oriented Design and analyze the case study for the UML notations.

**CO-4:** Draw activity and state chart diagram for real word applications for evaluating a class diagram and object diagram for user requirements

**CO-5:** Design case studies and model it in different views with respect user requirement such as use case, logical, component and deployment and etc, and preparation of document of the project for the unified Attendance application.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| 1 | System Development - Object Basics - Development Life Cycle - Methodologies - Patterns - Frameworks - Unified Approach – UML | 12 | CO-1 | K1 , K2 |
| 2 | Use-Case Models - Object Analysis - Object relations - Attributes - Methods - Class and Object responsibilities - Case Studies | 12 | CO-2 | K2 |
| 3 | Design Processes - Design Axioms - Class Design - Object Storage - Object Interoperability - Case Studies | 12 | CO-3 | K3 |
| 4 | User Interface Design - View layer Classes - Micro-Level Processes - View Layer Interface - Case Studies | 12 | CO-4 CO-5 | K4 |
| 5 | Quality Assurance Tests - Testing Strategies - Object orientation on testing - Test Cases - test Plans - Continuous | 12 | CO-5 | K5, K6 |

| | | | | |
|---|---|---|---|---|
| | testing - Debugging Principles - System Usability - Measuring User Satisfaction - Case Studies | | | |

**TEXT BOOKS:**

1. Ali Bahrami - Object Oriented Systems Development - McGraw Hill International Edition – 1999
2. Grady Booch- Object Oriented Analysis and design with applications–Addison Wesley, 2007
3. UML Distilled: A Brief Guide to the Standard Object Modeling Language, Martin Fowler, 3rd Edition, 2003

**REFERENCE BOOKS:**

1. Ramnath, Sarnath, and Brahma Dathan. *Object-oriented analysis and design*. Springer Science & Business Media, 2010.
2. Kahate, Atul. *Object Oriented Analysis & Design*. Tata McGraw-Hill Education, 2004

| **Elective Paper Theory – II** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **ARTIFICIAL NEURAL NETWORKS** | | |
| Category of the course | Year | Semester | Credits |
| **Elective** | **II** | **III** | **3** |
| Paper mainly focuses on | **SKILL DEVELOPMENT** | | |

**COURSE OBJECTIVES:**

- To learn and apply artificial neural networks in problem solving and use of heuristics based on human experience
- To introduce various neural network algorithms such as perceptron algorithms, Backpropagation algorithms, etc.
- To become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inferencing systems

**COURSE OUTCOMES:**

**CO-1:** Comprehend the relationship between biological neuron and artificial neuron and its working procedures.

**CO-2:** Apply Artificial Neural Network to implement Forward propagation and Back Propagation algorithms with various weight training methods.

**CO-3:** Analyze associative memory such as Hopfield Net and Bidirectional Associative memory using neural network approach.

**CO-4:** Evaluate various supervised and unsupervised learning methods using single level and multilevel neural networks.

**CO-5:** Review the various applications of neural network models by comparing and contrasting different types of neural network models

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | Introduction: Biological neurons - McCulloch and Pitts models of neuron - Types of activation function - Network architectures - Knowledge representation. | 12 | CO-1 | K1 |
| II | Single Layer Perceptron: Perceptron convergence theorem, Method of steepest descent - least mean square algorithms- Multilayer Perceptron: Derivation of the back-propagation algorithm, Learning Factors. | 12 | CO-1<br>CO-2 | K2 |
| III | Supervised and Unsupervised Learning – Statistical Learning – AI Learning – Neural Network Learning – Rule Based Neural Networks – Network Training –Decision Tree Based NN – Constraint Based NN. | 12 | CO-3 | K3 |

| | | | | |
|---|---|---|---|---|
| IV | Heuristics- Hierarchical Models – Hybrid Models – Parallel Models – Differentiation Models- Control Networks. | 12 | CO-4<br>CO-5 | K4, K5 |
| V | Structures and Sequences – Spatio-temporal NN – Learning Procedures – Knowledge based Approaches. | 12 | CO-5 | K6 |

**TEXT BOOKS:**

1. Limin Fu - Neural Networks in Computer Intelligence – McGraw Hill International Edition – 1994.
2. Robert J Schalkoff – Artificial Neural Networks – McGraw Hill – 1997.
3. Simon Haykin, ìNeural Network a - Comprehensive Foundationî, Pearson Education

**REFERENCE BOOKS:**

1. Zurada J.M., ìIntroduction to Artificial Neural Systems, Jaico publishers
2. Thimothy J. Ross, ìFuzzy Logic with Engineering Applicationsî, McGraw Hill
3. Ahmad Ibrahim, ìIntroduction to Applied Fuzzy Electronicsî, PHI

| **Elective Paper Theory – II** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS** | | |
| Category of the course | Year | Semester | Credits |
| **Elective** | **II** | **III** | **3** |
| Paper mainly focuses on | **SKILL DEVELOPMENT** | | |

**COURSE OBJECTIVES:**

- To understand the various characteristics of Intelligent agents
- To learn about the different search strategies in AI
- To learn to represent knowledge in solving AI problems
- To understand the different ways of designing Expert systems.

**COURSE OUTCOMES:**

**CO-1:** Demonstrate knowledge of the building blocks of AI as presented in terms of intelligent agents and Expert Systems.

**CO-2:** Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game-based techniques to solve them.

**CO-3:** Develop intelligent algorithms for knowledge representation using AI programming languages. and also design intelligent systems for Game Playing

**CO-4:** Experiment logic grammars for creating semantic structures for Natural Language processing.

**CO-5:** Formulate the capability to represent various real life problem domains using logic-based techniques and use this to perform inference or planning.

| **UNIT NO.** | **SYLLABUS** | **HOURS** | **COs** | **COGNITIVE LEVEL** |
|---|---|---|---|---|
| I | Artificial Intelligence and its Issues - Definitions - Importance of AI - Evolution of AI - Applications of AI - Classification of AI systems with respect environment - Knowledge Inferring systems and Planning - Uncertainty and towards Learning Systems. | 12 | CO-1 | K1,K2 |
| II | Overview to Problem Solving Problem solving by Search, Problem space - State space - Blind Search – Types – Performance measurement - Heuristic Search - Types – Game playing mini-max algorithm - Alpha-Beta Pruning. | 12 | CO-1 CO-2 | K3 |

| | | | | |
|---|---|---|---|---|
| III | Knowledge Representation and Reasoning - Logical systems Knowledge Based systems, Propositional Logic Constraints - Predicate Logic First Order Logic - Inference in First Order Logi - Ontological Representations and applications. | 12 | CO-3 | K3, K4 |
| IV | Uncertainty and knowledge Reasoning – Overview- Definition of uncertainty, Bayes Rule Inference, Belief Network, Utility Based System, Decision Network - Module -Learning Systems - Forms of Learning Types – Supervised - Unsupervised, Reinforcement Learning - Learning Decision Trees. | 12 | CO-4 CO-5 | K5 |
| V | Expert Systems - Expert Systems - Stages in the development of an Expert- System – Probability based Expert Systems - Expert System Tools - Difficulties in Developing Expert Systems - Applications of Expert Systems. | 12 | CO-5 | K5, K6 |

**TEXT BOOKS:**


1. Russell Stuart, Norvig Peter, 2004, "Artificial Intelligence – A Modern Approach", 2nd Edition Pearson Education.
2. Poole, D. and Mackworth, A. 2010. Artificial Intelligence: Foundations of Computationa Agents, Cambridge University Press.
3. I. Bratko, ―Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.


**REFERENCE BOOKS:**


1. Rich Elaine, Knight Kevin, "Artificial Intelligence", 2003,2nd Edition, Tata McGraw-Hill,
2. Nilsson J.Nils, "Artificial Intelligence: A new Synthesis" ,2000, Harcourt Asia Pvt. Ltd.,
3. Luger F. George, "Artificial Intelligence-Structures and Strategies for Complex Problem Solving", 2002,Pearson Education.

| **Elective Paper Theory – II** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **FUNDAMENTALS OF MACHINE LEARNING** | | |
| Category of the course | Year | Semester | Credits |
| **Elective** | **II** | **III** | **4** |
| Paper mainly focuses on | **SKILL DEVELOPMENT** | | |

**COURSE OBJECTIVES:**

- To introduce students to the basic concepts and techniques of Machine Learning.
- To have a thorough understanding of the Supervised and Unsupervised learning techniques
- To study the various probability-based learning techniques
- To understand graphical models of machine learning algorithms

**COURSE OUTCOMES:**

**CO-1:** Understand the concepts of Linear Regression methods and classification methods and their types of learning standard.

**CO-2:** Apply Linear learning methods such as resampling procedures for model selection and regularization procedures for dimensionality reduction.

**CO-3:** Analyze Non-linear learning methods such as polynomial regression, regression splines and tree-based methods.

**CO-4:** Evaluate Support Vector Machines for regression and classification.

**CO-5:** Design an unsupervised learning using principal component analysis and clustering methods.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | **LEARNING-STANDARD LINEAR METHODS**: Statistical Learning: What Is Statistical Learning, Assessing Model Accuracy. Linear Regression: Simple Linear Regression, Multiple Linear Regressions, Other Considerations in the Regression Model, The Marketing Plan, Comparison of Linear Regression with K-Nearest Neighbors. Classification: An Overview of Classification, Why Not Linear Regression? - Logistic Regression, Linear Discriminant Analysis, A Comparison of Classification Methods. | 12 | CO-1 | K1 |
| II | **SELECTION AND IMPROVEMENTS OF LINEAR LEARNING METHODS**: Resampling Methods: Cross-Validation, The Bootstrap. Linear Model Selection and | 12 | CO-2 | K2, K3 |

| | | | | |
|---|---|---|---|---|
| | Regularization: Subset Selection, Shrinkage Methods, Dimension Reduction Methods, Considerations in High Dimensions. | | | |
| III | **NON-LINEAR LEARNING METHODS**: Polynomial Regression, Step Functions, Basis Functions, Regression Splines, Smoothing Splines, Local Regression, Generalized Additive Models, Tree-Based Methods: The Basics of Decision Trees. Bagging, Random Forests, Boosting. | 12 | CO-3 | K3 |
| IV | **SUPPORT VECTOR MACHINES, PRINCIPAL COMPONENT ANALYSIS AND CLUSTERING**: Support Vector Machines: Maximal Margin Classifier. Support Vector Classifiers: Support Vector Machines, SVMs with More than Two Classes Relationship to Logistic Regression. | 12 | CO-4<br>CO-5 | K4, K5 |
| V | **UNSUPERVISED LEARNING**: The Challenge of Unsupervised Learning, Principal Components Analysis, Clustering Methods: K-Means Clustering, Hierarchical Clustering, Practical Issues in Clustering. | 12 | CO-5 | K6 |

**TEXT BOOKS:**


1. Stephen Marsland, ―Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, ―Machine Learning‖, First Edition, McGraw Hill Education, 2013.
3. Peter Flach, ―Machine Learning: The Art and Science of Algorithms that Make Sense of Data‖, First Edition, Cambridge University Press, 2012.


**REFERENCE BOOKS:**


1. Jason Bell, ―Machine learning – Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014
2. Ethem Alpaydin, ―Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)‖, Third Edition, MIT Press, 2014

| **Elective Paper Theory – III** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **CRYPTOGRAPHY AND NETWORK SECURITY** | | |
| Category of the course | Year | Semester | Credits |
| **Elective** | **II** | **III** | **3** |
| Paper mainly focuses on | **EMPLOYABILITY** | | |

**COURSE OBJECTIVES:**

- To understand security design principles
- To learn secure programming techniques
- To understand the mathematics behind cryptography
- To know the standard algorithms used to provide confidentiality, integrity and authenticity

**COURSE OUTCOMES:**

**CO-1:** Demonstrate knowledge of mathematics of cryptography, traditional symmetric key cipers and modern key cipers.

**CO-2:** Analyze and formalize the Data Encryption Standard (DES) and Advanced Encryption Standard (AES)

**CO-3:** Develop Asymmetric Key Cryptography for message integrity and authentication.

**CO-4:** Experiment different types of cryptographic hash function and digital signature.

**CO-5:** Formulate the Entity authentication and key management using Asymmetric and Symmetric key distribution

| **UNIT NO.** | **SYLLABUS** | **HOURS** | **COs** | **COGNITIVE LEVEL** |
|---|---|---|---|---|
| I | **INTRODUCTION:** Security Goals – Attacks – Services and Mechanism – Techniques. Mathematics of Cryptography: Integer Arithmetic – Modular Arithmetic – Matrices – Linear Congruence - Traditional Symmetric Key Ciphers: Instruction – Substitution Ciphers – Transposition Ciphers – Stream and Block Ciphers. **INTRODUCTION TO MODERN SYMMETRICKEY CIPHERS**: Modern Block Ciphers – Modern Stream Ciphers. | 12 | CO-1 | K1 |
| II | **DATA ENCRYPTION STANDARD (DES)**: Introduction – DES Structure – DES Analysis – Multiple DES – Security of DES. Advanced Encryption Standard (AES): Introduction – Transformations – Key Expansion – Ciphers – Examples – Analysis of AES. | 12 | CO-1 CO-2 | K1, K2 |
| III | **ASYMMETRIC KEY CRYPTOGRAPHY**: Introduction – RSA Crypto System. Message Integrity and Message Authentication: Message Integrity – Random Oracle Model – Message Authentication. | 12 | CO-3 | K3 |

| | | | | |
|---|---|---|---|---|
| IV | **CRYPTOGRAPHIC HASH FUNCTIONS:** Introduction – SHA – WHIRLPOOL.**DIGITAL SIGNATURE:** Comparison – Process – Services – Attacks on Digital Signature – Digital Signature Schemes. | 12 | CO-4<br>CO-4 | K4 |
| V | **ENTITY AUTHENTICATION:** Introduction – Passwords – Challenge Response – Zero Knowledge – Bio Metrics. **KEY MANAGEMENT:** Symmetric Key Distribution – Kerberos – Symmetric Key Agreement – Public Key Distribution. | 12 | CO-5 | K5, K6 |

**TEXT BOOKS:**

1. Cryptography and Network Security – Behrouz A. Forouzan, TheMcGraw Hill, 2011.
2. Cryptography and Network Security – William Stallings, PHI, 2008.
3. Cryptography and Network Security – Atul Kahate, McGraw Hill Education, 2013.

**REFERENCE BOOKS:**

1. Network Security The Complete Reference – Roberta Bragg, Mark Rhodes Ousley and Strassberg – McGraw Hill Education, 2003.
2. Bruce Schneier, ―Applied Cryptography Protocols, Algorithms and Source Code in C‖, Second Edition, John Wiley and Sons Inc., 2006.

| **Elective Paper Theory – III** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **PARALLEL COMPUTING** | | |
| Category of the course | Year | Semester | Credits |
| **Elective** | **II** | **III** | **3** |
| Paper mainly focuses on | **SKILL DEVELOPMENT** | | |

**COURSE OBJECTIVES:**

- To understand the need and fundamentals of parallel computing paradigms
- To learn the nuances of parallel algorithm design
- To understand the programming principles in parallel and distributed computing architectures
- To learn few problems that are solved using parallel algorithms

**COURSE OUTCOMES:**

**CO-1**: Define the scope of parallel computing, design paradigms and model of parallel computing.

**CO-2:** Perform classification of parallel computing based on Divide and Conquer strategies.

**CO-3:** Apply the parallel programming design paradigms and programming models and standards.

**CO-4:** Deduce shared memory concepts used in parallel computing models such as openMP.

**CO-5:** Design a Multi-core programming Tread building blocks and cilk++ programming.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | Introduction to Parallel Computing: Why Parallel Computing & Scope of Parallel Computing, Sieve of Eratosthenes, Control and Data Approach, PRAM model of parallel computation, Design paradigms of Parallel Computing,examples, Bulk Synchronous Parallel (BSP) model. | 12 | CO-1 | K1, K2 |
| II | Classification: Flynn's Taxonomy, MPP, SMP, CC-NUMA, Clustering of Computers, Beowulf Cluster, Use of MPI in Cluster Computing. Debugging, Evaluating and tuning of Cluster Programs, Partitioning and Divide and Conquer Strategies. Cluster: dedicated high performance (HP), high availability (HA), CoPs, PoPs, CoWs; distributed, on-demand, high-throughput, collaborative, data-intensive computing, Interconnection networks. | 12 | CO-2 | K2, K3 |
| III | An overview of Parallel Programming Paradigms: Foster's design paradigm for Multi computing programming, Programmability Issues, Programming Models: Message passing, Message passing standards: PVM (Parallel Virtual | 12 | CO-3 | K4 |

| | | | | |
|---|---|---|---|---|
| | Machine), MPI (Message Passing Interface) and its routines, Advanced Features of MPI. | | | |
| IV | Overview of Programming with Shared Memory: Overview of Programming with Shared Memory: OpenMP (History, Overview, Programming Model, OpenMP Constructs, Performance Issues and examples, Explicit Parallelism: Advanced Features of Open MP) | 12 | CO-4 | K4, K5 |
| V | Multi-Core programming: Multi-Core programming: Introduction to Multi cores Programming Software Multi-threading using Tread Building Blocks (TBB) and Cilk++ programming, GPGPU programming with CUDA. | 12 | CO-5 | K5, K6 |

**TEXT BOOKS:**


1. Quinn, M. J., Parallel Computing: Theory and Practice (McGraw-Hill Inc.).
2. Bary Wilkinson and Michael Allen: Parallel Programming Techniques using Networked of workstations and Parallel Computers, Prentice Hall, 1999.
3. R. Buyya High Performance Cluster Computing: Programming and Applications, Prentice Hall


**REFERENCE BOOKS:**


1. William Gropp, Rusty Lusk, Tuning MPI Applications for Peak Performance, Pittsburgh (1996).
2. W. Gropp, E. Lusk, N. Doss, A. Skjellum, A high performance portable implementation of the message passing Interface (MPI) standard, Parallel Computing.
3. Gibbons, A., W. Rytter, Efficient Parallel Algorithms (Cambridge Uni. Press).
4. Shameem A and Jason, Multicore Programming, Intel Press, 2006.
5. CUDA Programming A Developer's Guide to Parallel Computing with GPUs Shane Cook, Morgan Kaufmann.

| **Elective Paper Theory – III** | | | |
|---|---|---|---|
| Title of the paper withsubject code | **DISTRIBUTED DATABASE MANAGEMENT SYSTEMS** | | |
| Category of the course | Year | Semester | Credits |
| **Elective** | **II** | **III** | **3** |
| Paper mainly focuses on | **SKILL DEVELOPMENT** | | |

**COURSE OBJECTIVES:**

- To know advanced concepts in databases in large scale analytics.
- To learn concepts behind parallel, distributed, active, spatial, temporal and object databases.
- To learn reasoning and query processing.
- To understand the concurrency control in distributed databases

**COURSE OUTCOMES:**

**CO-1:** Explain the techniques used for data fragmentation, replication, and allocation during the distributed database design process.

**CO-2:** Analyze simple strategies for executing a distributed query to select the strategy that minimizes the amount of data transfer.

**CO-3:** Apply the two-phase commit protocol to deal with committing a transaction that accesses databases stored on multiple nodes.

**CO-4:** Validating distributed concurrency control based on the distinguished copy techniques and the voting methods.

**CO-5:** Build Architecture for deploying Distributed Database model to replace a centralized University examination system.

| UNIT NO. | SYLLABUS | HOURS | COs | COGNITIVE LEVEL |
|---|---|---|---|---|
| I | Features of Distributed versus Centralized Databases – Why Distributed Databases – Distributed Database Management Systems (DDBMSs)- Levels of Distribution Transparency- Reference Architecture for Distributed Databases – Types of Data Fragmentation – Distribution Transparency for read-only Applications – Distribution transparency for Update Applications – Distributed Database Access Primitives – Integrity Constraints in Distributed Databases - A Framework for Distributed Database Design – The Design of Database Fragmentation – The Allocation of Fragments. | 12 | CO-1 | K1,K2 |
| II | Equivalence Transformations for Queries – Transforming Global Queries into Fragment Queries – Distributed | 12 | CO-2 | K2 |

| | | | | |
|---|---|---|---|---|
| | Grouping and Aggregate Function Evaluation – Parametric Queries -Optimization of Access Strategies - A Framework for Query Optimization – Join Queries – General Queries. A Framework for Transaction Management – Supporting Atomicity of Distributed Transactions – Concurrency Control for Distributed Transactions – Architectural Aspects of Distributed Transactions. | | | |
| III | Foundations of Distributed Concurrency Control – DistributedDeadlocks – Concurrency Control Based on Timestamps – Optimistic Methods for Distributed Concurrency Control - Reliability – Basic Concepts Nonblocking Commitment Protocols – Reliability and Concurrency Control. | 12 | CO-3 | K3,K4 |
| IV | Distributed object database management systems – Fundamental object concepts and Models – Object – Abstract Data Types – Composition (Aggregation) – Class – Collection – Sub typing and Inheritance. – Object Distribution Design – Horizontal Class Partitioning –Vertical Class Partitioning – Path Partitioning – Class Partitioning Algorithms - Allocation – Replication – Query Processing Issues – Query Execution – Correctness Criteria – Transaction Models and Object Structures – Transactions Management in Object DBMSs – Transactions as Objects – Conclusion. | 12 | CO-4<br>CO-5 | K5 |
| V | Parallel Database Systems – Database Server Approach – Database Servers and Distributed Databases – Parallel System Architectures – Objectives – Functional Aspects – Parallel Data Processing – Parallel Query Optimization – Data Placement – Query Parallelism – Parallel Execution Problems – Initialization – Interferences and Convoy Effect – Load Balancing – Parallel Execution for Hierarchical Architecture – Problem Formulation – Basic Concepts – Load Balancing Strategy – Performance Evaluation – Conclusion. | 12 | CO-5 | K5, K6 |

**TEXT BOOKS:**


1.Stefano Ceri, Giuseppe Pelagatti, Distributed Databases Principles & Systems, McGraw-Hill.

2.M.Tamer Ozsu, Patrick Valduriez, Distributed database systems, 2nd Edition,Prentice Hall of India, New Delhi.

3.Raghu Ramakrishnan, ―Database Management Systems‖, Fourth Edition, McGraw-

Hill College Publications, 2015.

**REFERENCE BOOKS:**


1. Abraham Silberschatz, Henry F. Korth and S. Sudharshan, ―Database System Concepts‖, Sixth Edition, McGraw-Hill Education, 2010.
2. C.J.Date, A.Kannan and S.Swamynathan, ―An Introduction to Database Systems‖, Eighth Edition, Pearson Education, 2006.

## 8. PROGRAM OUTCOMES ( PO)

**PO-1.** Enriching the knowledge in theoretical and practical aspects.

**PO-2.** Developing research aptitude among the students and encouraging them to take up research projects and publish research papers.

**PO-3.** Enabling the students to come out successfully in competitive examinations.

**PO-4.** Developing students' skills, based on current trends by offering Job oriented, Entrepreneurial, certificate courses and Value-added courses.

## 8.1 PROGRAMME SPECIFIC OUTCOME FOR MSC COMPUTER SCIENCE

**PSO-6.** Ability to apply knowledge of basic sciences, mathematics, statistics and physics into computer science for solving real world problems.

**PSO-7.** Ability to learn various software tools, programming languages and apply algorithmic models thus making them more employable.

**PSO-8.** Students equipped with state-of-the-art technologies and cutting-edge solutions so as to enable them to foray into Entrepreneurship.

**PSO-9.** Students enriched with requisite and holistic skills to embrace themselves for competitive exams like NET, SET and other exams for career prospects.

**PSO-10.** Students with a drive and passion for Research aptitude and motivated enough for venturing into Advanced Research.

**PO – PSO MATRIX**

| | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** |
|---|---|---|---|---|---|
| **PO-1** | ✓ | | | | |
| **PO-2** | | | | | ✓ |
| **PO-3** | | | | ✓ | |
| **PO-4** | | ✓ | ✓ | | |

| Title of the paper with subject code | **PRINCIPLES OF COMPILER DESIGN** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **4** |

**COURSE OUTCOMES:**

**CO-1:** Comprehend the five phases of the compiler design and describe the nitty-gritty of functions of each of the phases.

**CO-2:** Application of Regular Expression and Finite Automata for Lexical analysis of the language to describe the tokens and to recognize the tokens respectively by the compilers.

**CO-3:** Analysis of parsing procedures by compare and contrast of various bottom-up and top-down parsing methods.

**CO-4:** Evaluate the intermediate codes of the compiler and inspect optimization techniques for the intermediate code.

**CO-5:** Synthesize a machine code of a trivial compiler for the design of Identifier token by constructing Regular Expression, Automata, Grammars, building a parser and an optimized intermediate code for the identifier

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | ✓ | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | ✓ | ✓ |
| **CO-3** | ✓ | | | ✓ | ✓ |
| **CO-4** | ✓ | | ✓ | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | ✓ | ✓ |

| Title of the paper with subject code | **PRINCIPLES OF ALGORITHM DESIGN** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **4** |

**COURSE OUTCOMES:**

**CO-1:** Understanding of steps in design of algorithms and analysis of time complexity and space complexity using asymptotic notation.

**CO-2:** Describe and differentiate 5 broad types of design methods such as Divide and Conquer, Greedy, Backtracking, Branch and Bound, Dynamic Programming

**CO-3:** Demonstrate knowledge about significance of each of the methods and differentiating various methods in solving specific problems.

**CO-4:** Evaluating the performance of the methods in solving problems using time complexity analysis with asymptotic notation.

**CO-5:** Design an algorithm for travelling salesman problem using 5 methods.

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | ✓ | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | | | | ✓ | ✓ |
| **CO-3** | ✓ | | | ✓ | ✓ |
| **CO-4** | ✓ | ✓ | | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | ✓ | ✓ |

| Title of the paper with subject code | **DISTRIBUTED COMPUTING** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **4** |

**COURSE OUTCOMES:**

**CO-1:** Demonstrate knowledge of evolution and designing model of distributed computing

**CO-2:** Analyze and formalize the IPC message passing and synchronization in multi-datagram messages.

**CO-3:** Develop distributed shared memory architecture, design and implementation issues in distributed shared memory.

**CO-4:** Experiment distributed file system, file models and design principles

**CO-5:** Formulate the security issues in distributed computing and cryptography for authentication access control.

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | ✓ | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | | |
| **CO-3** | ✓ | | | | ✓ |
| **CO-4** | ✓ | | | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | | ✓ |

| Title of the paper with subject code | **MICROSERVICES ARCHITECTURE** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **4** |

**COURSE OUTCOMES:**

**CO-1:** Demonstrate knowledge of client-side and server Java script features such as Datatypes, operators, methods, branching and looping constructs, classes and objects.

**CO-2:** Analyze and formalize the browser object model DOM, Event handling and cookies.

**CO-3:** Develop knowledge in node.JS Asynchronous programming. JSON Server, Asynchronous Loops in modules.

**CO-4:** Experiment web applications with Express, REST APIs and MongoDB.

**CO-5:** Formulate the design issues with Microservices using node.js.

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | ✓ | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | ✓ | | |
| **CO-3** | ✓ | | ✓ | | |
| **CO-4** | ✓ | | ✓ | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | | ✓ |

| Title of the paper with subject code | **MICROSERVICES ARCHITECTURE LAB** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **3** |

**COURSE OUTCOMES:**

**CO-1:** Demonstrate knowledge of client-side and server Java script features such as Datatypes, operators, methods, branching and looping constructs, classes and objects.

**CO-2:** Analyze and formalize the browser object model DOM, Event handling and cookies.

**CO-3:** Develop knowledge in node.JS Asynchronous programming. JSON Server, Asynchronous Loops in modules.

**CO-4:** Experiment web applications with Express, REST APIs and MongoDB.

**CO-5:** Formulate the design issues with Microservices using node.js.

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | ✓ | | | | |
| **CO-2** | | ✓ | | | |
| **CO-3** | | ✓ | | | |
| **CO-4** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | | ✓ |

| **Core Practical – 2** | | | |
|---|---|---|---|
| Title of the paper with subject code | **PRINCIPLES OF ALGORITHM USING JAVA** | | |
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **I** | **3** |

**CO-1:** Understanding of practical program using Divide and conquer method to solve merge sort, quick sort and finding maximum and minimum of numbers.

**CO-2:** Device programs for Knapsack Problem, Tree vertex splitting and Job Sequencing using Greedy method.

**CO-3:** Demonstrate practical knowledge in writing programs for Multistage graphs, All Pairs Shortest Paths, String Editing, BFS and DFS using dynamic programming method.

**CO-4:** Evaluate the performance of programs for 8-queens problem and Hamiltonian cycles using Backtracking method.

**CO-5:** Design an algorithm for travelling salesman problem using 5 methods.

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | ✓ | | | | |
| **CO-2** | | ✓ | | | |
| **CO-3** | | ✓ | | | |
| **CO-4** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | | ✓ |

| Title of the paper with subject code | **THEORY OF COMPUTATION** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Extra Disciplinary** | **I** | **II** | **5** |

**COURSE OUTCOMES:**

**CO-1:** Describe foundations for computation and conversion steps for regular expression, finite automata and grammars.

**CO-2:** Analyze the types of Grammars, concentrate on Regular languages and Context Free grammars and its properties.

**CO-3:** Apply the pumping lemma for validating regular language and context free language and demonstrate algorithms for conversion between languages.

**CO-4:** Evaluate linear automata and push-down automata for a given regular language and context free language.

**CO-5:** Produce simple programs for a Turing Machine and List examples of undecidable problems

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | ✓ | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | ✓ | |
| **CO-3** | ✓ | | | ✓ | ✓ |
| **CO-4** | ✓ | ✓ | | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | ✓ | ✓ |

| Title of the paper with subject code | **DIGITAL IMAGE PROCESSING** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **II** | **4** |

**COURSE OUTCOMES:**

**CO-1:** Understand the concepts of Image sensing steps and Image representation for analog and Digital Image.

**CO-2:** Apply Image processing techniques for noise removal and image enhancement from Digital Image.

**CO-3:** Analyze Image transformation techniques for analog and digital image.

**CO-4:** Evaluate Image compression models such as Huffman coding, JPEG, etc. for a given Digital Image.

**CO-5:** Design a Fourier Transform model to convert an analog image to a digital image.

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | | |
| **CO-3** | ✓ | | | ✓ | ✓ |
| **CO-4** | ✓ | | ✓ | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | ✓ | ✓ |

| Title of the paper with subject code | **UNIX AND PERL PROGRAMMING** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **II** | **4** |

**COURSE OUTCOMES:**

**CO-1:** Understand all the UNIX utilities, the basic UNIX process structure and the UNIX file system

**CO-2:** Articulate simple UNIX filters, UNIX pipes and redirection, UNIX environment, traps, signals, and Regular Expressions.

**CO-3:** Deduce least one Shell scripting language and Classify system calls in UNIX

**CO-4:** Review the concepts of process, threads, and file structure,

**CO-5:** Compose a Shell scripting for creating an application with Inter process Communication using pipes, shared memory, semaphores and messages.

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | ✓ | |
| **CO-3** | ✓ | | | ✓ | |
| **CO-4** | ✓ | ✓ | | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | | ✓ |

| Title of the paper with subject code | **ETHICAL HACKING** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Elective** | **I** | **II** | **3** |

**COURSE OUTCOMES:**

**CO-1:** Understand the concepts of Ethical Hacking, Enterprise Information security Architecture.

**CO-2:** Discuss various forms of foot printing, Network scanning and protocols and techniques in HTTP Tunneling and IP Spoofing.

**CO-3:** Discuss how system hacking works and steganography applications and detection tools.

**CO-4:** Review various Malware threats and its countermeasures and Malware analysis

**CO-5:** Review various case study tools, techniques and counter measures for sniffing attacks and session hijacking.

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | | | ✓ | | |
| **CO-3** | | ✓ | ✓ | | ✓ |
| **CO-4** | ✓ | ✓ | ✓ | | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | ✓ | ✓ |

| Elective Paper Theory – 1 | | | |
|---|---|---|---|
| Title of the paper with subject code | **DATA MINING** | | |
| Category of the course | Year | Semester | Credits |
| **Elective** | **I** | **II** | **3** |

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | ✓ | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | | ✓ |
| **CO-3** | ✓ | | ✓ | | ✓ |
| **CO-4** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | ✓ | ✓ |

| Title of the paper with subject code | **INTERNET OF THINGS** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Elective** | **I** | **II** | **3** |

**COURSE OUTCOMES:**

**CO-1:** Understanding the diverse fields where IoT is being used and wider range of IoT-applications

**CO-2:** Comprehend how M2M value chains are converted to IoT value chains

**CO-3:** Analyze IoT architecture, reference model and different types of views in IoT model.

**CO-4:** Deduce how IoT can be applied to factories, Retail Industry, Business models and other smart applications.

**CO-5:** Review various Governance policies in privacy and security issues.

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | ✓ | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | | ✓ |
| **CO-3** | ✓ | | ✓ | | ✓ |
| **CO-4** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | ✓ | ✓ |

| Title of the paper with subject code | **DIGITAL IMAGE PROCESSING USING PYTHON LAB** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **II** | **3** |

**COURSE OUTCOMES:**

**CO-1:** Understand the Practical python programs of Image representation for analog and Digital Image.

**CO-2:** Apply Image processing techniques in python for noise removal and image enhancement from Digital Image.

**CO-3:** Analyze python programs for Image transformation techniques for analog and digital image.

**CO-4:** Evaluate Image compression models such as Huffman coding.

**CO-5:** Design a Fourier Transform model to convert an analog image to a digital image.

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | | |
| **CO-3** | ✓ | | | ✓ | ✓ |
| **CO-4** | ✓ | | ✓ | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | ✓ | ✓ |

| Title of the paper with subject code | **UNIX AND PERL PROGRAMMING LAB** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Core** | **I** | **II** | **3** |

**COURSE OUTCOMES:**

**CO-1:** Understand all the UNIX utilities, the basic UNIX process structure and the UNIX file system

**CO-2:** Articulate simple UNIX filters, UNIX pipes and redirection, UNIX environment, traps, signals, and Regular Expressions.

**CO-3:** Deduce least one Shell scripting language and Classify system calls in UNIX

**CO-4:** Review the concepts of process, threads, and file structure,

**CO-5:** Compose a Shell scripting for creating an application with Inter process Communication using pipes, shared memory, semaphores and messages.

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | ✓ | |
| **CO-3** | ✓ | | | ✓ | |
| **CO-4** | ✓ | ✓ | | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | | ✓ |

| Title of the paper with subject code | **COMMUNICATION NETWORK AND WIRELESS TECHNOLOGY** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Core** | **II** | **III** | **4** |

**COURSE OUTCOMES:**

**CO-1:** Comprehend the basics of communication network topologies, network switching types, OSI model.

**CO-2:** Understand the cellular network architecture and its evolution from first generation to third generation CDMA.

**CO-3:** Understand various types of Modulation technique such as ASK, FSK, PSK, QAM and PCM.

**CO-4:** Apply the knowledge in Wireless LANs along with the transmission techniques and IEEE 802 Architecture for wireless LAN.

**CO-5:** Design own Wireless networks using various WI-FI IEEE standards.

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | ✓ | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | ✓ | | | | |
| **CO-2** | ✓ | ✓ | ✓ | | |
| **CO-3** | | ✓ | ✓ | | |
| **CO-4** | | ✓ | ✓ | | |
| **CO-5** | | ✓ | ✓ | ✓ | ✓ |

| Title of the paper withsubject code | **OBJECT ORIENTED ANALYSIS AND DESIGN** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Extra Disciplinary** | **II** | **III** | **3** |

**COURSE OUTCOMES:**

**CO-1:** Recall the object-oriented concepts for analysis and design of systems and gather functional requirements.

**CO-2:** Analyze the real-world problems using the use case diagrams.

**CO-3:** Apply knowledge of OOPs concepts in Object Oriented Design and analyze the case study for the UML notations.

**CO-4:** Draw activity and state chart diagram for real word applications for evaluating a class diagram and object diagram for user requirements

**CO-5:** Design case studies and model it in different views with respect user requirement such as use case, logical, component and deployment and etc, and preparation of document of the project for the unified Attendance application.

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | ✓ | |
| **CO-3** | ✓ | | | ✓ | |
| **CO-4** | ✓ | | | | |
| **CO-5** | ✓ | ✓ | ✓ | | ✓ |

| Title of the paper with subject code | **ARTIFICIAL NEURAL NETWORK** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Elective** | **II** | **III** | **3** |

**COURSE OUTCOMES:**

**CO-1:** Comprehend the relationship between biological neuron and artificial neuron and its working procedures.

**CO-2:** Apply Artificial Neural Network to implement Forward propagation and Back Propagation algorithms with various weight training methods.

**CO-3:** Analyze associative memory such as Hopfield Net and Bidirectional Associative memory using neural network approach.

**CO-4:** Evaluate various supervised and unsupervised learning methods using single level and multilevel neural networks.

**CO-5:** Review the various applications of neural network models by comparing and contrasting different types of neural network models

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | ✓ | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | | ✓ |
| **CO-3** | ✓ | | ✓ | ✓ | ✓ |
| **CO-4** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | ✓ | ✓ |

| Title of the paper with subject code | **ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEM** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Elective** | **II** | **III** | **3** |

**COURSE OUTCOMES:**

**CO-1:** Comprehend the relationship between biological neuron and artificial neuron and its working procedures.

**CO-2:** Apply Artificial Neural Network to implement Forward propagation and Back Propagation algorithms with various weight training methods.

**CO-3:** Analyze associative memory such as Hopfield Net and Bidirectional Associative memory using neural network approach.

**CO-4:** Evaluate various supervised and unsupervised learning methods using single level and multilevel neural networks.

**CO-5:** Review the various applications of neural network models by comparing and contrasting different types of neural network models

| Subject Code | CO-1 | CO-2 | CO-3 | CO-4 | CO-5 |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | ✓ | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | PSO-1 (Applied Knowledge) | PSO-2 (Employability) | PSO-3 (Entrepreneurship) | PSO-4 (Competitive Exams & Further studies) | PSO-5 (Research) |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | | ✓ |
| **CO-3** | ✓ | | ✓ | ✓ | ✓ |
| **CO-4** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | ✓ | ✓ |

| Title of the paper with subject code | **FUNDAMENTALS OF MACHINE LEARNING** | | |
|---|---|---|---|
| Category of the course | **Year** | **Semester** | **Credits** |
| **Elective** | **II** | **III** | **4** |

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | ✓ | ✓ | ✓ |
| **CO-3** | ✓ | | ✓ | | ✓ |
| **CO-4** | ✓ | ✓ | ✓ | | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | | ✓ |

| Title of the paper with subject code | **CRYPTOGRAPHY AND NETWORK SECURITY** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Elective** | **II** | **III** | **3** |

**COURSE OUTCOMES:**

**CO-1:** Demonstrate knowledge of mathematics of cryptography, traditional symmetric key cipers and modern key cipers.

**CO-2:** Analyze and formalize the Data Encryption Standard (DES) and Advanced Encryption Standard (AES)

**CO-3:** Develop Asymmetric Key Cryptography for message integrity and authentication.

**CO-4:** Experiment different types of cryptographic hash function and digital signature.

**CO-5:** Formulate the Entity authentication and key management using Asymmetric and Symmetric key distribution

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | ✓ | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | | | ✓ | | ✓ |
| **CO-3** | ✓ | | ✓ | ✓ | ✓ |
| **CO-4** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | | ✓ |

| Title of the paper with subject code | **PARALLEL COMPUTING** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Elective** | **II** | **III** | **3** |

**COURSE OUTCOMES:**

**CO-1:** Define the scope of parallel computing, design paradigms and model of parallel computing.

**CO-2:** Perform classification of parallel computing based on Divide and Conquer strategies.

**CO-3:** Apply the parallel programming design paradigms and programming models and standards.

**CO-4:** Deduce shared memory concepts used in parallel computing models such as openMP.

**CO-5:** Design a Multi-core programming Tread building blocks and cilk++ programming

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | | ✓ |
| **CO-3** | ✓ | | | ✓ | ✓ |
| **CO-4** | ✓ | | ✓ | | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | | ✓ |

| Title of the paper with subject code | **DISTRIBUTED DATABASE MANAGEMENT SYSTEM** | | |
|---|---|---|---|
| Category of the course | Year | Semester | Credits |
| **Elective** | **II** | **III** | **3** |

**COURSE OUTCOMES:**

**CO-1:** Explain the techniques used for data fragmentation, replication, and allocation during the distributed database design process.

**CO-2:** Analyze simple strategies for executing a distributed query to select the strategy that minimizes the amount of data transfer.

**CO-3:** Apply the two-phase commit protocol to deal with committing a transaction that accesses databases stored on multiple nodes.

**CO-4:** Validating distributed concurrency control based on the distinguished copy techniques and the voting methods.

**CO-5:** Build Architecture for deploying Distributed Database model to replace a centralized University examination system.

| **Subject Code** | **CO-1** | **CO-2** | **CO-3** | **CO-4** | **CO-5** |
|---|---|---|---|---|---|
| **Unit-1** | ✓ | | | | |
| **Unit-2** | | ✓ | | | |
| **Unit-3** | | | ✓ | | |
| **Unit-4** | | | | ✓ | ✓ |
| **Unit-5** | | | | | ✓ |

**PSO- CO MATRIX**

| | **PSO-1 (Applied Knowledge)** | **PSO-2 (Employability)** | **PSO-3 (Entrepreneurship)** | **PSO-4 (Competitive Exams & Further studies)** | **PSO-5 (Research)** |
|---|---|---|---|---|---|
| **CO-1** | | | | | |
| **CO-2** | ✓ | | | | |
| **CO-3** | ✓ | | | ✓ | |
| **CO-4** | ✓ | | | ✓ | ✓ |
| **CO-5** | ✓ | ✓ | ✓ | | ✓ |

**9. Teaching – Learning Process:**

The Teaching-Learning process for the B.Sc. Computer Science programme has been in alignment with the course objectives and outcomes put forth for the programme. It has been ensured that the process is in compliance with the Programme Specific Outcomes and Course Outcomes envisaged for the programme. To enable effective and efficient teaching process various teaching aids have been used including online classes through Google Meet. To facilitate better learning process for the students the Institution has offered online repository such as Google Classroom for online sharing of reading resources and contents to the students.

To meet the set objectives of the course and enable students achieve the expected outcomes of the course the following teaching processes are utilized:

**Class Room Teaching:**

Time tested regular Class room teaching and face-to-face teaching using chalk and talk method is used to imbibe the theoretical foundations to the students. Using Live Classroom teaching provides teachers with a handle to monitor the mindset of the students and grasp of the teaching. LCD/Projectors can be used in classroom for providing simulated/animated explanations of the concepts of the curriculum.

**Laboratory Teaching:**

Laboratory Teaching provides hands-on practical sessions for the students to have deep understanding of the theoretical concepts that they learn in classrooms. Laboratory is furnished with state-of-the-art technologies and higher-end software to help students to solve the problems practically.

**Forums:**

Student forum in the name of ITALERT Forum is organized every week where Industry experts are invited to provide Guest Lectures for the students to learn the latest trends and technologies prevalent in the industry. Forums are also used for peer-to-peer learning as students take seminars, involve themselves in group discussions on technical topics.

**MOOCS:**

Students are advised to take up MOOC course such as NPTEL and other industry endorsed online courses to provide blended learning to cater to the needs of the ever-evolving field of Computer Science.

**Project:**

Students are subjected to carryout Project-based assignments for every core subject. Students are a given a real-time problem. They are to apply the theoretical concepts to the problems, analyse the technical details of the problem, evaluate the possible solutions to the problem and have to propose a computational solution for the given problem.

Final year students in their final semester are mandated to complete a real-time mini-project for the successful completion of the degree.

**Assignments:**

Home assignments are regularly given to students that comprises of

**7** Data collection from real-world to prepare themselves to gain insights to the data by comparing the data from various sources and preparing a report for the collected data.

**8** Solve theoretical problems using practical approaches to provide exposure to real-world problems and industry practices.

**10. Assessment Methods:**

Assessment methods play a pivotal role in evaluation of student's progress. More importantly the Assessments methods employed are structured in such a way that students can themselves introspect as to what is expected of them by the Institution and by the Industry. Assessment methods provide students with window to know where they lack as a learner and more importantly how to improve upon themselves from the inputs of the curriculum. In bachelors programme of Computer Science, the assessment and evaluation method focus on testing the intuitive understanding of the fundamental concepts of software and hardware along with programming skills in various languages and more importantly the ability to apply the knowledge to real-life applications. The assessment methods try to validate and enhance the well-rounded skillsets of the students such as employable skills, entrepreneurship skills, research-relevance skills and programming-conscious skills.

### 10.1 Continuous Assessment:

The Continuous assessment occurs on a regular and continuous basis, it is an ongoing formative and summative process, involving the monitoring of students. This assessment is inherently integrated with teaching and involves of series of process like systematic collection of marks or grades that gradually flow into the final score. The assessment marks or grades collected through various stages of the semester eventually contribute to the final grade of the students.

The continuous Assessment process tests the students on various grounds and aspects such as:

- Continuous Internal Assessment – I
- Continuous Internal Assessment – II
- Continuous Internal Assessment – III
- Attendance
- Class Participation or seminars
- Assignments

The student is subjected to three internal assessment written exams in a semester. The student's regular class attendance proves to be an important factor in the evaluation of the student's credentials. The assessment also takes cognizance of the student's active participation in the class room discussions in the form of seminars and group discussions. The prompt submission of home assignments is monitored for assessing the student's final evaluation of their credentials. The overall marks secured in the Continuous Assessment Process contributes for 25% of the total marks secured in the end-semester examinations.

### 11. Keywords:

Learning Outcome, Graduate Descriptor, Qualification Descriptor, Skill Enhancement, Core Compulsory Courses, Discipline Specific Elective, Continuous Assessment, Assessment methods, CO, PSO, Teaching-Learning process