SCHEME OF EX MIN TION

&

SYLL BI

for

Bachelor of Technology Programmes of Studies under the aegis of University School of Information, Communication & Technology offered at ffiliated Institutions of the University

(1st Year Common Scheme and Syllabus and 2nd Year onwards Scheme and Syllabus)

P RT – II

(for Scheme of Examination and Syllabi for Bachelor of Technology (Computer Science) offered at ffiliated Institutions of the University)

GURU GOBIND SINGH
INDRAPRASTHA
UNIVERSITY

University School of Information, Communication &Technology

Sector 16C, Dwarka, Delhi – 110 078 [INDIA]

www.ipu.ac.in

CONTENTS

Particulars	Page No
1. Approval History	4
2. Important Notes	5
3. Provision for Smooth Implementation	6
4. Programme Outcomes	7
5. Acronyms and Definitions	8
6. Common Scheme and Syllabus of First Year	10
7. Bridge Courses for the B.Tech Lateral Entry Students	14
8. Bachelor of Technology in Computer Science (CS) - 2nd Year Onward Scheme and implementation guideline	15
9. Minor Specialization to be Offered	27
9.1. Emerging Area Elective (EAE) Groups (for Minor Specialization)	28
9.2. Open Area Elective (OAE) Groups (for Minor Specialization)	35
10. Syllabus of 1st Year Onward Papers	39

Approval History:

1. Scheme of Examination and Syllabi for Bachelor of Technology (Computer Science) offered at Affiliated Institutions of the University from 2023-24 batch i.e. Part-II approved by ____ Board of Studies of USICT held on dated _____.
2. Scheme of Examination and Syllabi for Bachelor of Technology (Computer Science) offered at Affiliated Institutions of the University from 2023-24 batch i.e. Part-II approved by Academic Council Sub-committee on dated _____.

Important Notes:

1. This document contains the Scheme of Examination and Syllabi for **Bachelor of Technology (Computer Science)** offered at Affiliated Institutions of the University.

2. This document is hereinafter refered to as **Part – II** of the earlier approved Scheme of Examination and Syllabi for Bachelor of Technology Programmes of Studies under the aegis of University School of Information, Communication & Technology offered at Affiliated Institutions of the University (approved by BoS on 24/08/2023 & AC subcommittee on 29/09/2023 and uploaded on website of the university at http://www.ipu.ac.in/Pubinfo2022/syllBTechAff130423.pdf dated: 18.10.2023; *hereinafter refered to as* **Part – I)**.

3. The 1st Year Scheme and Syllabi for **B.Tech (Computer Science)** is also common as that of all other disciplines of B.Tech as described in Part – I (Page Nos. 9 – 12 and 14 - 51)

4. Bridge Courses for the **B.Tech (Computer Science)** Lateral Entry students is also same as that of all other disciplines of B.Tech as described in Part – I (Page No. 13 and 301-304)

Provision for Smooth Implementation

This document describes the curriculum of the Bachelor of Technology Programmes that are (or allowed to be) offered at the affiliated institutions of Guru Gobind Indraprastha University, Delhi, under the aegis of the University School of Information, Communication and Technology. In the event of any difficulty of implementation, and / or interpretation of any clause of the document, the same may be brought to the notice of Dean of the University School of Information Communication and Technology. The decision of the Dean, University School of Information Communication and Technology shall be final and implemented to resolve the issue. The same shall be put up in the subsequent meeting of the Board of Studies of the University School of Information Communication and Technology for its approval. If the decision of the Board of Studies of the University School of Information Communication and Technology is at variance with the decision taken earlier by the Dean of the School, the decision of the Board shall be effective from the date of the approval by the Board of Studies. In the interim period (between the approval of the Dean, of the School and the Board of Studies approval), the decision already taken by the Dean of the school shall stand.

Note for implementation

The textbooks recommended by AICTE vide its public notification (Annexure 1 of the Part-I) and its amendments from time to time, may be utilized by the concerned teachers for teaching of subjects in any discipline (as relevant).

The Outcome Based Education Framework implementation was approved by the BoS. The framework as decided by the APC and of the school is shall be implemented w.e.f batch of Academic Sessuion 2023-24.

The marking scheme for all non-NUES papers (theory/practical) to be as:

1. **Teachers Continuous Evaluation: 40 marks**
2. **Term end Theory Examinations: 60 marks**

w.e.f from the batch of A.S.: 2023-24 onwards (for lateral entry this provision shall be applicable from admissions through lateral entry from admissions in the academic session 2024-25). For earler batch (regular) admitted in the year 2021-22 and 2022-23 (and corresponding lateral entry admissions), the marking scheme for all non-NUES papers (theory/practical) to be as defined within this document, that is, NUES papers out of 100, Theory to have 25 marks for Teachers Continuous Evaluation and 75 marks for term end examinations while the corresponding bifurcation for practicals/projects/dissertation to be 40:60.

Programme Outcomes

1. **Engineering Knowledge** (**PO01**): Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem Analysis** (**PO02**): Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

3. **Design/Development of Solutions** (**PO03**): Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct Investigations of Complex Problems** (**PO04**): Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems:

    a. that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline as against problems given at the end of chapters in a typical text book that can be solved using simple engineering theories and techniques;

    b. that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions;

    c. that require consideration of appropriate constraints / requirements not explicitly given in the problem statement such as cost, power requirement, durability, product life, etc.;

    d. which need to be defined (modelled) within appropriate mathematical framework; and

    e. that often require use of modern computational concepts and tools, for example, in the design of an antenna or a DSP filter.

5. **Modern Tool Usage** (**PO05**): Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society** (**PO06**): Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability** (**PO07**): Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics** (**PO08**): Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work** (**PO09**): Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication** (**PO10**): Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance** (**PO11**): Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long Learning** (**PO12**): Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Acronyms for Core Disciplines:

CSE : Computer Science and Engineering
IT : Information Technology
CST : Computer Science and Technology
ITE : Information Technology and Engineering
ECE : Electronics and Communications Engineering
EE : Electrical Engineering
EEE : Electrical and Electronics Engineering
ICE : Instrumentation and Control Engineering
ME : Mechanical Engineering
CE : Civil Engineering
CS : Computer Science

Acronyms for Emerging Area Disciplines:

MAE : Mechanical and Automation Engineering
CSE-AI : Computer Science and Engineering (Artificial Intelligence)
CSE-AIML : Computer Science and Engineering (Artificial Intelligence and Machine Learning)
CSE-DS : Computer Science and Engineering (Data Science)
CSE-IoT : Computer Science and Engineering (Internet of Things)
CSE-ICB : Computer Science and Engineering (Internet of Things and Cyber Security including Block Chain Technology)
CSE-Net : Computer Science and Engineering (Networks)
CSE-CS : Computer Science and Engineering (Cyber Security)
EE-VDT : Electronics Engineering (VLSI Design and Technology)
EC-ACT : Electronics and Communication (Advanced Communication Technology)

Acronyms for Minor Specializations*(Applicable only for Core Disciplines)*:

AI : Artificial Intelligence
AIML : Artificial Intelligence and Machine Learning
DS : Data Science
BT : Block Chain Technology
IoT : Internet of Things
ICB : Internet of Things and Cyber Security including Block Chain Technology
Net : Networks
CS : Cyber Security
MLDA : Machine Learning and Data Analytics
SC : Soft Computing
SE : Software Engineering
FSD : Full Stack Development
IPCV : Image Processing and Computer Vision
RA : Robotics and Automation
ES : Embedded Systems
VLSI : VLSI Design
WMC : Wireless and Mobile Communications
EV : Electrical Vehicles
MT : Microgrid Technologies
PS : Power Systems
PED : Power Electronics and Drives
CI : Control and Instrumentation
CADM : Computer Aided Design and Manufacturing
DMS : Design and Measurement Systems
DT : Design Trends
TES : Thermal Energy Sources
QM : Quality Management
CTM : Construction Technology and Management
IE : Infrastructure Engineering
GTSE : Green Technology and Sustainability Engineering

CSE : Computer Science and Engineering
ECE : Electronics and Communications Engineering
EE : Electrical Engineering
SD : Software Development
ME : Mechanical Engineering
ICE : Instrumentation and Control Engineering
CE : Civil Engineering
UHV : Universal Human Values

Acronyms for Course / Paper Groups and Codes:

BS : Basic Science
HS : Humanities, Social Science
MS : Management Studies
ES : Engineering Science
MC : Mandatory Courses
PC : Programme Core, that is course/paper offered in the discipline of the programme as a compulsory paper.
PCE : Programme Core Elective, that is elective course/paper offered in the discipline of the programme.
EAE/OAE: Emerging Area Elective / Open Area Elective offered in the institution
CIC : Computer Science / IT Core
CIE : Computer Science / IT Elective
ECC : Electronics Core
ECE : Electronics Elective
EEC : Electrical Core
EEE : Electrical Elective
ICC : Instrumentation Core
ICE : Instrumentation Elective
MEC : Mechanical Core
MEE : Mechanical Elective
CEC : Civil Core
CEE : Civil Elective
MAC : Automation Core
MAO : Automation Open Elective

Definitions:

Batch: The batch of the student shall mean the year of the first time enrolment of the students in the programme of study in the first semester. Lateral entry students admitted in the 3rd semester / 2nd year shall be designated as students admitted in the previous batch as they are admitted one year later. A student re-admitted in a programme of study in a lower / later batch shall be considered as the student of the original batch for the purpose calculation of duration of study (lateral entry o readmission due to academic break).

Programme of study shall mean Bachelor of Technology.

Major / Primary specialization / discipline shall mean the discipline in which the student is admitted / upgraded or transferred.

Minor specialization shall mean the specializations earned through the EAE or OAE route subject to fulfilment of requirements specified in the scheme of study for the concerned minor specialization.

Other Acronyms:

PCC : Programme Coordination Committee
APC : Academic Programme Committee comprising of all faculty of the department / institutions and as defined in the implementation rules and the Ordinance 11 of the University.
L : Number of Lecture hours per week
T/P : Number of Tutorial / Practical Hours per week
C : Number of credits assigned to a course / paper
COE : Controller of Examinations of the Examinations Division of the University.
SGPA/CGPA : Semester/Cumulative Grade Point Average.
NUES : Non University Examination System - No term end examination shall be held. The evaluation shall be conducted as per the scheme of examinations as described in the scheme of study.

FIRST YEAR

Common Scheme and Syllabus

for

All Bachelor of Technology Programmes of Study under the aegis of University School of Information, Communication & Technology offered at Affiliated Institutions of the University

In light of the eligibility condition specified in the **AICTE Process Handbook 2022-23** (Page Nos 89 and 90), the **Chemistry Papers BS-121 / BS-120 entitled "Basic Chemistry"** shall be offered to students admitted from Academic Session 2022-23 (in the 1st/ 2ndSemester) in lieu of **Chemistry Papers BS-103 / BS-104 entitled "Applied Chemistry".** This shall be offered only to students who have not studied Chemistry at 10+2 Level and are admitted to the following disciplines only:

1) Computer Science and Engineering (CSE)
2) Information Technology (IT)
3) Computer Science and Technology (CST)
4) Information Technology and Engineering (ITE)
5) Electronics and Communications Engineering (ECE)
6) Electrical Engineering (EE)
7) Electrical and Electronics Engineering (EEE)
8) Instrumentation and Control Engineering (ICE)
9) Computer Science (CS)
10) Computer Science and Engineering (Artificial Intelligence) (CSE-AI)
11) Computer Science and Engineering (Artificial Intelligence and Machine Learning) (CSE-AIML)
12) Computer Science and Engineering (Data Science) (CSE-DS)
13) Computer Science and Engineering (Internet of Things) (CSE-IoT)
14) Computer Science and Engineering (Internet of Things and Cyber Security including Block Chain Technology) (CSE-ICB)
15) Computer Science and Engineering (Networks) (CSE-Net)
16) Computer Science and Engineering (Cyber Security) (CSE-CS)
17) Electronics Engineering (VLSI Design and Technology) (EE-VDT)
18) Electronics and Communication (Advanced Communication Technology) (EC-ACT)

Note: The corresponding practical paper (BS-155 / BS-156) shall be unchanged.(Addition from AY 2022-23)

First Semester					
Group	**Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
ES BS	ES-101 BS-103/BS-121#	*Any one of the following: Programming in 'C' Applied Chemistry / Basic Chemistry#	3	-	3
BS	BS-105	Applied Physics – I	3	-	3
ES BS	ES-107 BS-109	*Any one of the following: Electrical Science Environmental Studies	3	-	3
BS	BS-111	Applied Mathematics – I	4	-	4
HS HS HS	HS-113 HS-115 HS-117	**Group 1 or Group 2 shall be offered: Group 1: Communications Skills OR Group 2: Indian Constitution*** Human Values and Ethics***	3 2 1	-	3 2 1
ES	ES-119	Manufacturing Process	4	-	4
Practical/Viva Voce					
BS	BS-151	Physics-I Lab	-	2	1
ES BS	ES-153 BS-155	Any of the following corresponding to the theory paper offered: Programming in 'C' Lab Applied Chemistry	-	2	1
ES	ES-157	Engineering Graphics-I	-	4	2
ES BS	ES-159 BS-161	Any of the following corresponding to the theory paper offered: Electrical Science Lab Environmental Studies Lab	-	2	1
Total			**20**	**10**	**25**

*For a particular batch of a programme of study one out of these two papers shall be taught in the first semester while the other shall be taught in the 2nd semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 1st semester and similarly for the students who study the paper in the second semester. The institution shall decide which paper to offer in which semester.

**For a particular batch of a programme of study either the paper on "Communications Skills" (Group 1), or Group 2: papers ("Indian Constitution" and "Human values and ethics") shall be taught in the first semester while the other group shall be taught in the 2nd semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 1st semester and similarly for the students who study the paper(s) in the second semester. The institution shall decide which paper group to offer in which semester.

***NUES:** All examinations to be conducted by the concerned teacher as specified in the detailed syllabus of the paper.

#The students who have not studied Chemistry at 10+2 level shall be offered BS-121 in lieu of BS-103, as applicable in applicable disciplines. (Addition from the Academic Session 2022-23)

Group	Code	Paper	L	P	Credits
HS/MS	HS-352	NSS / NCC / Cultural Clubs / Technical Society / Technical Club*			2

***NUES:** Comprehensive evaluation of the students by the concerned coordinator of NCC / NSS / Cultural Clubs / Technical Society / Technical Clubs, out of 100 as per the evaluation schemes worked out by these activity societies, organizations; the co-ordinators shall be responsible for the evaluation of the same. These activities shall start from the 1st semester and the evaluation shall be conducted at the end of the 6th semester for students admitted in the first semester. Students admitted in the 2nd year (3rd semester) as lateral entry shall undergo training or participate in the activities for the period of 3rd semester to 6th semester only

Second Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
ES BS	ES-102 BS-104/BS-120#	*Any one of the following: Programming in 'C' Applied Chemistry / Basic Chemistry#	3	-	3
BS	BS-106	Applied Physics – II	3	-	3
ES BS	ES-108 BS-110	*Any one of the following: Electrical Science Environmental Studies	3	-	3
BS	BS-112	Applied Mathematics – II	4	-	4
HS HS HS	HS-114 HS-116 HS-118	**Group 1 or Group 2 shall be offered: Group 1: Communications Skills OR Group 2: Indian Constitution*** Human Values and Ethics***	3 2 1	-	3 2 1
ES	ES-114	Engineering Mechanics	3	-	3
Practical/Viva Voce					
BS	BS-152	Physics-II Lab	-	2	1
ES BS	ES-154 BS-156	*Any of the following corresponding to the theory paper offered: Programming in 'C' Lab Applied Chemistry	-	2	1
ES	ES-158	Engineering Graphics-II	-	2	1
ES BS	ES-160 BS-162	*Any of the following corresponding to the theory paper offered: Electrical Science Lab Environmental Studies Lab	-	2	1
ES	ES-164	Workshop Practice		4	2
Total			**19**	**12**	**25**

*For a particular batch of a programme of study one out of these two papers shall be taught in the first semester while the other shall be taught in the 2nd semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 1st semester and similarly for the students who study the paper in the second semester. The institution shall decide which paper to offer in which semester.

**For a particular batch of a programme of study either the paper on "Communications Skills" (Group 1), or Group 2: papers ("Indian Constitution" and "Human values and ethics") shall be taught in the first semester while the other group shall be taught in the 2nd semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 1st semester and similarly for the students who study the paper(s) in the second semester. The institution shall decide which paper group to offer in which semester.

***__NUES__:** All examinations to be conducted by the concerned teacher as specified in the detailed syllabus of the paper.

#The students who have not studied Chemistry at 10+2 level shall be offered BS-120 in lieu of BS-104, as applicable in applicable disciplines. (Addition from the Academic Session 2022-23)

BRIDGE COURSES FOR THE B.TECH L TER L ENTRY STUDENTS

All the Lateral Entry students of B.Tech., who are directly admitted in the 2nd Year / 3rd Semester of the Progarmme of Study, have to pass the following bridge courses.

Paper Code	Paper Name	L/P
BC-181	Bridge Course in Mathematics	3
BC-183	Bridge Course in Programming in C	3

Implementation Rules for Bridge Courses:

1. The institutions are required to conduct the classes for the above bridge courses in the 3rd Semester along with the classes of the other courses.
2. These papers have to be qualified by the students.
3. For these papers examination shall be conducted by the concerned subject teacher as NUES, the same shall be transferred to Examination Division of the University.
4. The degree to be awarded to the student only subject to the acquiring qualifying grade/marks in the bridge courses and the minimum credits in the regular courses of the scheme of study as prescribed.
5. These Courses shall be qualifying in nature; they shall not be included for calculation of CGPA. The qualifying marks shall be 40 marks in each paper.
6. A separate marksheet will be issued by the Examination Division of the University for the Bridge Course.

Bachelor of Technology in Computer Science (CS)

2nd Year Onward Scheme and implementation guideline

Third Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
ES	ES-201	Computational Methods	4		4
HS/MS	HS-203	Indian Knowledge System*	2		2
PC	CIC-205	Discrete Mathematics	4		4
PC	ECC-207	Digital Logic and Computer Design	4		4
PC	CIC-209	Data Structures	4		4
PC	CIC-211	Object-Oriented Programming using C++	4		4
Practical / Viva Voce					
ES	ES-251	Computational Methods Lab		2	1
PC	ECC-253	Digital Logic and Computer Design Lab		2	1
PC	CIC-255	Data Structures Lab		2	1
PC	CIC-257	Object-Oriented Programming using C++ Lab		2	1
Total			**22**	**8**	**26**

***NUES:**All examinations to be conducted by the concerned teacher as specified in the detailed syllabus of the paper.

Fourth Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
BS	BS-202	Probability, Statistics and Linear Programming	4		4
HS/MS	HS-204	Technical Writing*	2		2
PC	CIC-206	Theory of Computation	4		4
PC	CIC-214	Operating Systems	4		4
PC	CIC-216	Computer Networks	4		4
PC	CIC-218	Functional and Logic Programming	4		4
Practical / Viva Voce					
BS	BS-252	Probability, Statistics and Linear Programming Lab		2	1
PC	CIC-260	Operating Systems Lab		2	1
PC	CIC-262	Computer Networks Lab		2	1
PC	CIC-264	Functional and Logic Programming Lab		2	1
Total			**22**	**8**	**26**

***NUES:**All examinations to be conducted by the concerned teacher as specified in the detailed syllabus of the paper.

Fifth Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
HS/MS	HS-301	Economics for Engineers	2		2
PC	CIC-303	Compiler Design	3		3
PC	CIC-309	Software Engineering	3		3
PC	CIC-311	Design and Analysis of Algorithm	4		4
PC	CIC-315	Database Management Systems	4		4
PC	CIC-317	Programming in Java	4		4
Practical / Viva Voce					
PC	CIC-351	Compiler Design Lab		2	1
PC	CIC-357	Software Engineering Lab		2	1
PC	CIC-359	Design and Analysis of Algorithm Lab		2	1
PC	CIC-367	Database Management Systems Lab		2	1
PC	CIC-369	Programming in Java Lab		2	1
PC / Internship	ES-361	Summer Training Report - 1 *			1
Total		-	**20**	**10**	**26**

***NUES:**Comprehensive evaluation of the Summer Training Report – 1 (after 4th Semester) shall be done by the committee of teachers, constituted by the Academic Programme Committee, out of 100. The training shall be of 4 to 6 weeks duration. The training can be under the mentorship of a teacher of the institute.

Sixth Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
HS/MS	MS-302	Principles of Management for Engineers	3		3
HS/MS	HS-304	Universal Human Values*	1		1
PCE		Programme Core Elective Paper (PCE –1)			4
PCE		Programme Core Elective Paper (PCE – 2)			4
PCE		Programme Core Elective Paper (PCE – 3)			4
EAE / OAE		Emerging Area/Open Area Elective Paper (EAE – 1 /OAE – 1)			4
EAE / OAE		Emerging Area/Open Area Elective Paper (EAE – 2 /OAE – 2)			4
Practical / Viva Voce					
HS/MS	HS-352	NSS / NCC / Cultural Clubs / Technical Society / Technical Club**			2
Total					**26**

***NUES:**All examinations to be conducted by the concerned teacher as specified in the detailed syllabus of the paper.

****NUES:**Comprehensive evaluation of the students by the concerned coordinator of NCC / NSS / Cultural Clubs / Technical Society / Technical Clubs, out of 100 as per the evaluation schemes worked out by these activity societies, organizations; the faculty co-ordinators shall be responsible for the evaluation of the same. These activities shall start from the 1st semester and the evaluation shall be conducted at the end of the 6th semester for students admitted in the first semester. Students admitted in the 2nd year (3rd semester) as lateral entry shall be evaluated on the basis their performance, by the faculty co-ordinator for the period of 3rd semester to 6th semester only.

Seventh Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
HS/MS	MS-401	Principles of Entrepreneurship Mindset	2		2
PCE		Programme Core Elective Paper (PCE – 4)			4
PCE		Programme Core Elective Paper (PCE – 5)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 3 / OAE – 3)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 4 / OAE – 4)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 5 / OAE – 5)			4
Practical / Viva Voce					
PC / Project	ES-451	Minor Project**			3
PC / Internship	ES-453	Summer Training Report - 2 *			1
Total					**26**

***NUES**:Comprehensive evaluation of the Summer Training Report – 2 (after 6th Semester) shall be done by the committee of teachers, constituted by the Academic Programme Committee, out of 100. The training shall be of 4 to 6 weeks duration. The training can be under the mentorship of a teacher of the institute.

**The student shall be allocated a supervisor / guide for project work at the end 6th semester by the department / institution, the project shall continue into the 8th semester. In the 7th semester evaluation, the criteria for evaluation shall be conceptualization of the project work, the background study / literature survey and identification of objectives and methodology to be followed for project. 40 marks evaluation for the Teachers' Continuous Evaluation / Internal Assessment shall be done by concerned supervisor while the term end examination of 60 marks shall be conducted by the supervisor concerned and the external examiner deputed by the Examinations Division. In the absence of the supervisor, the Director of the Institution / Head of the Department can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the Institution / Department.

Eight Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Practical / Viva Voce%					
PC / Project	ES-452	Major Project – Dissertation and Viva Voce#			18
	ES-454	Project Progress Evaluation*			2
PC / Internship	ES-456	Internship Report and Viva Voce#			18
	ES-458	Internship Progress Evaluation*			2
Total			**0**	**0**	**20**

***NUES: Comprehensive evaluation by the committee of teachers, constituted by the Academic Programme Committee, out of 100.**

%By default every student shall do the project work (ES-452 and ES-454). A student shall either be allowed to do a project work (ES-452 and ES-454) or an internship (ES-456 and ES-458). The student must apply for approval to do internship before the commencement of the 8th semester to the institute, and only after approval of Principal / Director of the institute through Training and Placement Officer of the institute, shall proceed for internship.

#Students may be allowed to do internship in this semester in lieu of Major project. The students allowed to proceed for internship shall be required to maintain a log-book of activities performed during internship. The same has to be countersigned by the mentor at the organization where internship is completed.

ES-452: Evaluation shall be conducted of 40 marks (Teachers' continuous evaluation / internal assessment) by the supervisor. And, 60 marks by a bench of the supervisor and the external examiner deputed by Examination Division (COE), for a total of 100 marks.

ES-454 / ES-458: Comprehensive evaluation by the committee of teachers, constituted by the Academic Programme Committee, out of 100.

ES-456: Evaluation shall be conducted of 40 marks (Teachers' continuous evaluation / internal assessment) by the Training and Placement Officer of the department / institute on the basis of the report submitted by the student. And, 60 marks by a bench of the Training and Placement Officer of the department / institute and the external examiner deputed by Examination Division (COE), for a total of 100 marks.

In the absence of the supervisor or the Training and Placement Officer (as the case may be), the Director of the institute / Head of the Department can assign the responsibility of the supervisor or the Training and Placement Officer (for purpose of examinations) to any faculty of the department.

Note on Elective Papers: The elective papers shall be allowed to be taken / studied by the students, by the APC of the department / institute, keeping in view that two papers studied by the student should not have a substantial overlap. All papers studied by the student should be substantially distinct in content.

Note on Continuous Evaluation of All Papers (Theory and Lab/Practical): Papers shall have 40 Marks continuous evaluation by the teacher and 60 Marks term-end examinations. Both these component marks shall be reflected on the marksheet of the student.

**** The mid-term test shall be coordinated by the Programme Coordination Committee.***

If a student could not appear for a mid-term test due to situation beyond the control by the student, a supplementary test may be arranged towards the end of the semester, in a similar manner to the mid-term test for such students. The students must apply for this provision to the department / institution. On examination of the reason for non-appearing in the mid-term test by the Head of the Department / Institute, and with reason for allowing to appear in the supplementary test to recorded by the Head of the Department / Institute, the student may be allowed.

The attendance sheets, the question papers and the award sheets for the continuous evaluation to be retained by the concerned department / institute for at least 6 months after the declaration of the result by the Examination Division of the University.

Programme Core Electives

Semester	Paper Code	PCE – 1 (Choose Any One)	L	P	Credits
6	CIE-306T	Advanced Java Programming	3		3
	CIE-306P	Advanced Java Programming Lab		2	1
6	CIE-308T	Visual Basic.NET Programming	3		3
	CIE-308P	Visual Basic.NET Programming Lab		2	1
6	CIE-312	Engineering Optimization	4		4
6	CIE-318T	Network Security and Cryptography	3		3
	CIE-318P	Network Security and Cryptography Lab		2	1
6	CIE-320	Principles of Programming Languages	4		4
Semester	**Paper Code**	**PCE – 2 (Choose Any One)**	**L**	**P**	**Credits**
6	CIE-332T	Programming in Python	3		3
	CIE-332P	Programming in Python Lab		2	1
6	CIE-334	Quantum Computing	4		4
6	CIE-338T	Graph Theory for Computer Science	3		3
	CIE-338P	Graph Theory for Computer Science Lab		2	1
6	CIE-348T	Software Project Management	3		3
	CIE-348P	Software Project Management Lab		2	1
6	CIE-376T	Computer Graphics	3		3
	CIE-376P	Computer Graphics Lab		2	1
Semester	**Paper Code**	**PCE – 3 (Choose Any One)**	**L**	**P**	**Credits**
6	CIE-354T	Introduction to Digital Signal Processing	3		3
	CIE-354P	Introduction to Digital Signal Processing Lab		2	1
6	CIE-356T	Web Technologies	3		3
	CIE-356P	Web Technologies Lab		2	1
6	CIE-370T	Parallel Computing	3		3
	CIE-370P	Parallel Computing Lab		2	1
6	CIE-374T	Artificial Intelligence	3		3
	CIE-374P	Artificial Intelligence Lab		2	1
6	CIE-378	Complexity Theory	4		4
Semester	**Paper Code**	**PCE – 4 (Choose Any One)**	**L**	**P**	**Credits**
7	CIE-403T	Blockchain Technology	3		3
	CIE-403P	Blockchain Technology Lab		2	1
7	CIE-405T	Data Science	3		3
	CIE-405P	Data Science Lab		2	1
7	CIE-407T	Distributed Systems and Cloud Computing	3		3
	CIE-407P	Distributed Systems and Cloud Computing Lab		2	1
7	CIE-409T	Social Network Analysis and Sentiment Analysis	3		3
	CIE-409P	Social Network Analysis and Sentiment Analysis Lab		2	1
7	CIE-433T	Software Verification, Validation and Testing	3		3
	CIE-433P	Software Verification, Validation and Testing Lab		2	1
Semester	**Paper Code**	**PCE – 5 (Choose Any One)**	**L**	**P**	**Credits**
7	CIE-417T	C#.NET Programming	3		3
	CIE-417P	C#.NET Programming Lab		2	1
7	CIE-419	Intellectual Property Rights	4		4
7	CIE-421T	Machine Learning	3		3
	CIE-421P	Machine Learning Lab		2	1
7	CIE-425T	Data Warehousing and Data Mining	3		3
	CIE-425P	Data Warehousing and Data Mining Lab		2	1
7	CIE-435T	Network Programming	3		3
	CIE-435P	Network Programming Lab		2	1

Note:

1. An elective shall be offered to the student for each PCE group (That is for PCE-1, PCE-2, etc.) based on the availability of resources and faculty at the institution and at least one third of the batch or at least 20 students must be willing to take the elective. At least two elective per PCE group must be offered to the students of the major discipline.

2. Each PCE slot is of 4 credits, if in a particular slot, the paper has no practical component, then it is of 4 credits (a pure theory paper), otherwise for purpose of examination and conduct of classes, the course is split in two papers, namely a theory paper of 3 credits and a practical paper of 1 credit. The student has to study for 4 credits per slot of PCE group. This is reflected by suffixing the paper code by T (for Theory component) and P (for Practical component), if required.

Implementation Rules:

1. ***The examinations, attendance criteria to appear in examinations, promotion and award of the degree shall be governed by the Ordinance 11 of the University.*** The term "major discipline" / "primary discipline" in this document refers to the discipline in which student is admitted / studies from 3rd semester onwards. However credits of courses / paper for OAE / EAE groups shall not be considered for the purpose of promotion from one year of study to the subsequent year of study.

2. ***Minimum duration*** of the Bachelor of Technology programme shall be 4 years (N=4 years) (8 semesters)for the students admitted in the 1st year and 1st semester of the degree programme. Lateral entry students shall be admitted in the 2nd year and 3rd semester of the degree programme (effectively in the batch admitted in the first year in the previous academic session and shall be deemed to have been exempted from the courses / papers of the first year of the degree programme. No exemption certificate shall be issued in any case.

   A specific lateral entry students' minimum duration shall be the same as the minimum duration for the batch in which he/she is admitted as a lateral entry student in the 2nd year.

3. ***Maximum duration of the Bachelor of Technology programme shall be 6 years (N+2 years).*** After completion of N+2 years of study, if the student has appeared in the papers of all the semesters upto 8th semester, then a maximum extension of 1 year may be given to the student for completing the requirements of the degree if and only if the number of credits already earned by the student is atleast 150 (for lateral entry students it shall be at least 102 credits) from the (non-honours components). Otherwise, the admission of the student shall stand cancelled. After the period of allowed study, the admission of the student shall be cancelled.

   A specific lateral entry students' maximum duration shall be the same as the minimum duration for the batch in which he/she is admitted as a lateral entry student in the 2nd year.

4. ***The degree shall be awarded only after the fulfilment of all requirements of the Scheme and Syllabus of Examinations and the applicable Ordinance.***

5. (a) The students shall undergo the following group of Courses / Papers as enumerated in the scheme (***For the students admitted in the First Year / First Semester).***

Group	Semester (Credits)							Total Credits	Mandatory Credits
	I & II	III	IV	V	VI	VII	VIII		
BS	24		5					**29**	**14**
HS/MS	6	2	2	2	6	2		**20**	**10**
ES	20	5						**25**	**15**
PC		19	19	24		4	20	**86**	**76**
PCE					12	8		**20**	**16**
EAE/OAE					8	12		**20**	**16**
Total	**50**	**26**	**26**	**26**	**26**	**26**	**20**	**200**	**147**

TABLE 1: Distribution of Credits (Project / Internship credits are 25 out the 86 credits for Programme Core (PC) credits, while extra-curricular activities credits are 2 out of 20 credits for Humanities / Management / Social Science Group (HS/MS)) . This table is for students admitted in the First Year / First Semester of the Degree Programme.

(b) The students admitted as Lateral Entry shall undergo the following group of Courses / Papers as enumerated in the scheme**.**

Group	Semester (Credits)						Total Credits	Mandatory Credits
	III	IV	V	VI	VII	VIII		
BS		5					**5**	**0**
HS/MS	2	2	2	6	2		**14**	**7**
ES	5						**5**	**0**
PC	19	19	24		4	20	**86**	**76**
PCE				12	8		**20**	**16**
EAE/OAE				8	12		**20**	**16**
Total	**26**	**26**	**26**	**26**	**26**	**20**	**150**	**115**

TABLE 2: Distribution of Credits (Project / Internship credits are 25 out the 86 credits for Programme Core (PC) credits, while extra-curricular activities credits are 2 out of 14 credits for Humanities / Management / Social Science Group (HS/MS)) This table is for students admitted as Lateral Entry Students in the Second Year / Third Semester of the Degree Programme.

6. Mandatory Credits specify the number of credits from each subject group to be mandatorily acquired by the student for the award of the degree,for students admitted as students in the 1st year and 1st semester of the degree programme. While for students admitted as lateral entry in the 2nd year and 3rd semester the Mandatory Credits value is 115, and specify the number of credits from each subject group to be mandatorily acquired by the student for the award of the degree (Table 2). See clause 11 and 12 also**.**

7. Some of the papers are droppable in the sense that the student may qualify for the award of the degree even when the student has not cleared / passed some of the papers of these group. However, the student has to earn the minimum credits for the programme of study as specified. **See clause 11 and 12 also**.

8. The students may take 5 subjects from EAE / OAE groups. The open electives of the OAE group of courses may also be taken through SWAYAM / NPTEL MOOCs platform. The student desirous of doing a MOOC based course among the OAE group must seek approval of the APC of the institute for the same before the commencement of the semester. The APC shall allow the MOOC based OAE option to the student if and only if the MOOC subject / course being considered for the student is being offered in line with the Academic Calendar applicable. The student shall submit the successful completion certificate with marks to the institution for onwards transfer to the Examination Division. The Examinations Division shall take these marks on record for incorporation in the result of the appropriate semester. These marks / grades of these courses shall be used for calculation of the SGPA/CGPA of the student concerned by the examination division of the University. **If a student takes even one OAE paper through MOOCs, then the student shall not be eligible for minor specialization.** The degree to the student on fulfilment of other requirements for such cases shall be through **clause 12.b. or 12.c.**

   These MOOC courses taken by the students, if allowed by the APC of the institute shall be of 4 credits or more collectively to be against or for one paper slot in the scheme, through MOOCs, though the marks shall be shown individually. That is in one paper slot in the scheme wherever a MOOC course is allowed, the student may register for more than one paper to aggregate 4 credits or more. **If the credits of these MOOC Courses, allowed to a student is more than 4, then the maximum credit for the programme shall be amended accordingly for the particular student.** Also, in a particular semester, a student may take more than one MOOC course with the approval of the APC to meet the credit requirements of OAE for the semester. The cost of taking the MOOC course is to be borne by the concerned student. The results of the MOOC courses shall be declared separately by the Examination Division from the result for the papers conducted by the examination division of the University.

9. To earn an Honours degree, the student may enrol for 20 credits or more through SWAYAM / NPTEL MOOCs platform. This point has to be read together with other points specially point 13 and 14. The acquisition of the credits should be completed before the 15th of the July of the Admission Year plus 4 years. That is, if a student is admitted in the year X, then these credits must be acquired through MOOCs by 15th July of the year (X+4), no extra duration or time shall be allocated, this means, the student must submit the result of such papers on or before 15th July of the Admission Year plus 4 years.

   Honours in the degree shall be awarded if and only if at least 20 credits are acquired through MOOCs. To obtain Honours in the programme, the student must apply to the institution about the same before the commencement of the 5th semester. The specific courses through MOOCs shall be registered by the student only after approval by the Academic Programme Committee (APC) of the Institute. The APC shall approve the course if it is not already studied by the student or the student shall not study it in future and adds value to the major area of specialization (which is the degree). The papers for which the student desires to appear for Honours through MOOCs, all papers results shall be submitted by the student to the Institute for onwards transfer to Examination Division of the University, to be taken on record of the University. The results of these papers shall be a part of the records of the examinations of the students. The records shall be submitted by the student to the Institute, then transferred to the Examination Division, shall be notified by the Examination Division of the University, and a separate marksheet shall be issued by the Examination Division. The cost of taking the MOOC course is to be borne by the concerned student. Such courses shall be reflected as additional courses / papers for the student.

   If a student acquires less than 20 credits through MOOCs, following the mechanism specified, then also the results of these papers shall be taken on record as specified above, though no Honours degree shall be awarded.

   The papers through MOOCs for Honours degree shall not be a part of the set of the papers over which the SGPA / CGPA of the student shall be calculated.

   The papers through MOOCs for Honours degree shall be additional papers studied by the students and are to be taken into account only for award of Honours in the degree programme, if 20 credits are earned through MOOCs as approved by APC, by a student. **See Clause 13 also.**

10. Maximum Credits is at least 200 (Table 1) for students admitted in the 1st year and 1st semester, these are the credits for which the student shall have to study for the non-Honours component of the curriculum. And, for lateral entry students admitted in the 2nd year and 3rd semester of the degree programme, the maximum credit required to be studied is at least 150 (Table 2). **See clause 8 also**.

    The student has to appear in the examinations for these credits in all components of evaluation as specified in the scheme of studies.

11. Minimum Credits required to be earned is atleast 180 (out of the 200 non Honours papers credits, see clause 10 also) for students admitted in the 1st year and 1st semester. And, for lateral entry students admitted in the 2nd year and 3rd semester of the degree programme, the minimum credit required to be earned Is at least 135 (out of the 150 non Honours papers credits, see clause 10 also). See clause 6 also.

12. The following degree route can be taken by a student **(also refer point 13)**:

    a. The students shall be awarded one minor specialization, one from EAE/OEA route under the following conditions:

       i. The student has earned the mandatory credits as defined in Table 1 or Table 2 (as applicable) and clause 6.

       ii. The student earns 20 credits from one group of EAE / OAE courses offered as a minor specialization by the institute.

       iii. In addition, the total credits (including the above specified credits) earned by the student is atleast as **specified in clause 11**.

       The degree nomenclature of the degree shall be as: "***Bachelor of Technology in Computer Science with Minor Specializations in <concerned EAE/OAE discipline>***"; if criteria / **point 9** is not satisfied for Honours. Otherwise, if criteria / **point 9** is met, then the degree shall be an Honours degree and the

nomenclature shall be as: "***Bachelor of Technology in Computer Science with Minor Specializations in <concerned EAE/OAE discipline>) (Honours)"***, if in addition to **point 12.a.i, 12.a.ii, and 12.a.iii,** the student fulfils the criteria for Honours as specified at **point 9**.

b. The students shall be awarded the degree without any minor specialization under the following conditions:

   i. The student has earned the mandatory credits as defined in **Table 1** or **Table 2** (as applicable) and **clause 6**.

   ii. In addition, the total credits (including the above specified credits) earned by the student is atleast as specified in **clause 11**.

   The degree nomenclature of the degree shall be as: "***Bachelor of Technology in Computer Science";*** if criteria / **point 9** is not satisfied for Honours. Otherwise, if criteria / **point 9** is met, then the degrees shall be an Honours degree and the nomenclature shall be as: "***Bachelor of Technology in Computer Science (Honours)***", if in addition to **point 12.b.i and 12.b.ii**, the student fulfils the criteria for Honours as specified at **point 9**.

c. If the student does not fulfil any of the above criterions (**point 12.a, or 12.b**), if the student earns at least the minimum credits specified in clause 11 (disregarding the mandatory credits clause of **Table 1or Table 2 (as applicable)**and **Clause 6**), then the student shall be award the degree as "***Bachelor of Technology in Computer Science".*** Such students shall not be eligible for the award of an Honours degree. Though, if credits are accumulated through MOOCs as per **clause 9**, the same shall be reflected in the marksheets of the students.

13. ***The Honours degree shall only be awarded if the CGPA of the student is above or equal to 7.5 in addition to fulfilment of criteria / point 10 and 13 above and the degree is awarded after the immediate completion of the 4th year of the batch from the year of admission.*** No Honours shall be conferred if the degree requirements are not completed in the minimum duration.

14. ***Pass marks in every paper shall be 40.***

15. ***Grading System shall be as per Ordinance 11 of the University.***

16. The Programme Core Electives (PCE) shall be specific to a major discipline, minor specializations and papers for EAE shall be defined by the school defining the syllabus for the particular areas and minor specializations and papers for OAE shall be defined by the schools defining the elective streams.

17. **Minor specialization in non-engineering disciplines may be offered under the aegis of the other schools (provided the individual institutions are offering programmes under the aegis of the school offering the non-engineering minor specialization). The minor specialization framework of 20 credits has to be offered within the framework of the current Scheme of Studies of the primary / major discipline.**

18. The institution shall offer atleast two elective groups out of the emerging area / open area for students of each major discipline. The emerging area / open electives can also be offered as standalone papers not forming a part of any elective groups also. The institute shall decide the group(s) and/or individual papers to be offered as electives based on the availability of infrastructure and faculty. From the groups / papers offered by the institute, an elective paper / group shall be taught if and only if the number of students in a paper is at-least 20 or at-least 1/3 of the students of a major / primary discipline for which the paper / group is to be offered. The APC of the department / institute may define a maximum number of students allowed to register for a paper as an elective (EAE / OAE).

19. The institution shall offer atleast two elective papers from each program core elective group for students of each major / primary discipline. The institute shall decide the individual papers to be offered as electives (PCE) based on the availability of infrastructure and faculty. From the papers offered by the institute, an elective paper shall be taught if and only if the number of students in a paper is at-least 20 or at-least 1/3 of the students of a major / primary discipline for which the paper is to be offered. The APC of the department / institute may define a maximum number of students allowed to register for a paper as an elective (PCE).

20. Teachers of the other department(s), as and when deputed by their department, for teaching the students enrolled in programmes offered by the department offering the programme shall be a part of the

Academic Programme Committee of the discipline. Such teachers, for all academic matters, including teaching, teachers' continuous evaluation, term end examinations etc. shall be governed by the decisions of the APC of department offering the programme of study. Similarly, the guest faculty, the visiting faculty and the Contract / Ad Hoc faculty as and when deputed to teach students of a particular department shall form a part of APC of the department.

21. The Paper IDs will be generated / issued / assigned by the Examination Division of the University.

22. The medium of instructions shall be English.

MINOR SPECIALIZATION TO BE OFFERED

Emerging Area Elective (EAE) Groups (for Minor Specialization)

The minor specialization is offered through a set of five papers that the student has to study to acquire the minor specialization. The number of papers to be studied is two in 6th semester and three in 7th semester. The minor specialization shall be awarded if and only if 20 credits are earned from an individual / specific minor specialization area. From each paper group associated with a paper slot in a particular semester, the student shall be allowed to study only one paper group. The papers shall be allowed to be taken / studied by the students, by the APC of the department / institute, keeping in view that two papers studied by the student should not have a substantial overlap. All papers studied by the student should be substantially distinct in content.

Minor specialization is not necessary for award of the degree, the student may choose five papers from the groups offered by the institution to a particular student (belonging to a major discipline) across groups. Minimum two minor specialization groups should be offered by the institution to students of any particular major discipline from either of the open area or emerging area groups

An elective shall be offered to the student for each Minor Specialization group in Emerging Area (That is for EAE-1, EAE-2, etc.) based on the availability of resources and faculty at the institution and at least one third of the batch or at least 20 students must be willing to take the elective.

Each EAE slot is of 4 credits, if in a particular slot, the paper has no practical component, then it is of 4 credits (a pure theory paper), otherwise for purpose of examination and conduct of classes, the course is split in two papers, namely a theory paper of 3 credits and a practical paper of 1 credit. The student has to study for 4 credits per slot of EAE group. This is reflected by suffixing the paper code by T (for Theory component) and P (for Practical component), if required. The nomenclature of the paper group is <*ACRONYM OF EMERGING AREA*> - EAE - <SLOT NUMBER>< A or B or C etc., if required>. The major disciplines to which the Emerging Area Elective Group papers can be offered is specified as acronym together with the name of the minor specialization.

In lieu of Emerging Area Elective, students can study papers from Open Area Elective groups also as offered to them.

Emerging Area Specialization: Artificial Intelligence (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	AI-EAE-1	AI-302T	Artificial Intelligence	3		3
		AI-302P	Artificial Intelligence Lab		2	1
6	AI-EAE-2	DA-304T	Statistics, Statistical Modelling & Data Analytics	3		3
		DA-304P	Statistics, Statistical Modelling & Data Analytics Lab		2	1
7	AI-EAE-3	SC-401T	Soft Computing	3		3
		SC-401P	Soft Computing Lab		2	1
7	AI-EAE-4	AI-403T	Artificial Intelligence Applications	3		3
		AI-403P	Artificial Intelligence Applications Lab		2	1
7	AI-EAE-5	AI-405T	Intelligent and Expert Systems	3		3
		AI-405P	Intelligent and Expert Systems Lab		2	1

Emerging Area Specialization: Artificial Intelligence and Machine Learning (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	AIML-EAE-1	AI-302T	Artificial Intelligence	3		3
		AI-302P	Artificial Intelligence Lab		2	1
6	AIML-EAE-2	DA-304T	Statistics, Statistical Modelling & Data Analytics	3		3
		DA-304P	Statistics, Statistical Modelling & Data Analytics Lab		2	1
7	AIML-EAE-3	ML-407T	Machine Learning	3		3
		ML-407P	Machine Learning Lab		2	1
7	AIML-EAE-4	ML-409T	Reinforcement Learning and Deep Learning	3		3
		ML-409P	Reinforcement Learning and Deep Learning Lab		2	1
7	AIML-EAE-5	ML-411T	Pattern Recognition and Computer Vision	3		3
		ML-411P	Pattern Recognition and Computer Vision Lab		2	1

Emerging Area Specialization: Data Science (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	DS-EAE-1	DA-304T	Statistics, Statistical Modelling & Data Analytics	3		3
		DA-304P	Statistics, Statistical Modelling & Data Analytics Lab		2	1
6	DS-EAE-2	AI-316T	Artificial Intelligence and Machine Learning	3		3
		AI-316P	Artificial Intelligence and Machine Learning Lab		2	1
7	DS-EAE-3	DS-427T	Data Science using R	3		3
		DS-427P	Data Science using R Lab		2	1
7	DS-EAE-4	DS-429T	Big Data Analytics	3		3
		DS-429P	Big Data Analytics Lab		2	1
7	DS-EAE-5A OR	DS-431T	Business Intelligence	3		3
		DS-431P	Business Intelligence Lab		2	1
	DS-EAE-5B	DS-433T	Exploratory Data Analytics and Data Visualization	3		3
		DS-433P	Exploratory Data Analytics and Data Visualization Lab		2	1

Emerging Area Specialization: Block Chain Technology (for CSE/IT/CST/ITE/CS/ECE/EE/EEE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	BT-EAE-1	CS-306T	Mathematics of Modern Cryptography	3		3
		CS-306P	Mathematics of Modern Cryptography Lab		2	1
6	BT-EAE-2	BT-308T	Blockchain Technology	3		3
		BT-308P	Blockchain Technology Lab		2	1
7	BT-EAE-3	BT-413T	Bitcoin and Cryptocurrency Technologies	3		3
		BT-413P	Bitcoin and Cryptocurrency Technologies Lab		2	1
7	BT-EAE-4	BT-415T	Smart Contracts	3		3
		BT-415P	Smart Contracts Lab		2	1
7	BT-EAE-5A OR	BT-417T	Blockchain for Cyber Security	3		3
		BT-417P	Blockchain for Cyber Security Lab		2	1
	BT-EAE-5B	BT-419T	Blockchain Technology in Web Development	3		3
		BT-419P	Blockchain Technology in Web Development Lab		2	1

Emerging Area Specialization: Internet of Things (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE / ME)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	IOT-EAE-1A OR	IOT-324T	Introduction to Internet of Things	3		3
		IOT-324P	Introduction to Internet of Things Lab		2	1
	IOT-EAE-1B	IOT-326T	Introduction to Sensors and Transducers	3		3
		IOT-326P	Introduction to Sensors and Transducers Lab		2	1
6	IOT-EAE-2A OR	ES-328T	Embedded Linux	3		3
		ES-328P	Embedded Linux Lab		2	1
	IOT-EAE-2B OR	IOT-330T	Programming in Python	3		3
		IOT-330P	Programming in Python Lab		2	1
	IOT-EAE-2C	IOT-332T	Wireless Sensor Networks	3		3
		IOT-332P	Wireless Sensor Networks Lab		2	1
7	IOT-EAE-3	IOT-441T	IoT with Arduino, ESP and Raspberry Pi	3		3
		IOT-441P	IoT with Arduino, ESP and Raspberry Pi Lab		2	1
7	IOT-EAE-4	IOT-443T	Design of Smart Systems	3		3
		IOT-443P	Design of Smart Systems Lab		2	1
7	IOT-EAE-5A OR	IOT-445T	Internet of Things Industrial and Medical Case Studies	3		3
		IOT-445P	Internet of Things Industrial and Medical Case Studies Lab		2	1
	IOT-EAE-5B OR	IOT-447T	Internet of Things Frameworks	3		3
		IOT-447P	Internet of Things Frameworks Lab		2	1
	IOT-EAE-5C	IOT-449	Privacy and Security issues in IoT	4		4

Emerging Area Specialization: Internet of Things and Cyber Security including Block Chain Technology (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE / ME)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	ICB-EAE-1A OR	IOT-324T	Introduction to Internet of Things	3		3
		IOT-324P	Introduction to Internet of Things Lab		2	1
	ICB-EAE-1B	IOT-326T	Introduction to Sensors and Transducers	3		3
		IOT-326P	Introduction to Sensors and Transducers Lab		2	1
6	ICB-EAE-2A OR	ES-328T	Embedded Linux	3		3
		ES-328P	Embedded Linux Lab		2	1
	ICB-EAE-2B OR	IOT-330T	Programming in Python	3		3
		IOT-330P	Programming in Python Lab		2	1
	ICB-EAE-2C	IOT-332T	Wireless Sensor Networks	3		3
		IOT-332P	Wireless Sensor Networks Lab		2	1
7	ICB-EAE-3	CS-423T	Cyber Security and Forensics	3		3
		CS-423P	Cyber Security and Forensics Lab		2	1
7	ICB-EAE-4	IOT-441T	IoT with Arduino, ESP and Raspberry Pi	3		3
		IOT-441P	IoT with Arduino, ESP and Raspberry Pi Lab		2	1
7	ICB-EAE-5	BT-443T	Blockchain Technology	3		3
		BT-443P	Blockchain Technology Lab		2	1

Emerging Area Specialization: Networks (for CSE / IT / CST / ITE / CS / ECE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	NET-EAE-1	NET-344T	Advanced Computer Networks and Administration	3		3
		NET-344P	Advanced Computer Networks and Administration Lab		2	1
6	NET-EAE-2	NET-346T	Linux System Administration	3		3
		NET-346P	Linux System Administration Lab		2	1
7	NET-EAE-3	NET-471T	Network Programming	3		3
		NET-471P	Network Programming Lab		2	1
7	NET-EAE-4	NET-473T	Cloud Computing and Security	3		3
		NET-473P	Cloud Computing and Security Lab		2	1
7	NET-EAE-5	NET-475T	Wireless Sensor Networks	3		3
		NET-475P	Wireless Sensor Networks Lab		2	1

Emerging Area Specialization: Cyber Security (for CSE / IT / CST / ITE / CS / ECE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	CS-EAE-1	CS-310T	Information Theory and Coding	3		3
		CS-310P	Information Theory and Coding Lab		2	1
6	CS-EAE-2A OR	CS-312T	Network Security and Cryptography	3		3
		CS-312P	Network Security and Cryptography Lab		2	1
	CS-EAE-2B	CS-314T	Network Security Issues and Challenges	3		3
		CS-314P	Network Security Issues and Challenges Lab		2	1
7	CS-EAE-3	CS-421T	Cyber Crime and Cyber Laws	3		3
		CS-421P	Cyber Crime and Cyber Laws Lab		2	1
7	CS-EAE-4	CS-423T	Cyber Security and Forensics	3		3
		CS-423P	Cyber Security and Forensics Lab		2	1
7	CS-EAE-5	CS-425T	Ethical Hacking	3		3
		CS-425P	Ethical Hacking Lab		2	1

Emerging Area Specialization: Soft Computing (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	SC-EAE-1	DA-304T	Statistics, Statistical Modelling & Data Analytics	3		3
		DA-304P	Statistics, Statistical Modelling & Data Analytics Lab		2	1
6	SC-EAE-2	ML-348T	Artificial Neural Networks and Deep Learning	3		3
		ML-348P	Artificial Neural Networks and Deep Learning Lab		2	1
7	SC-EAE-3	SC-477T	Fuzzy Systems and Applications	3		3
		SC-477P	Fuzzy Systems and Applications Lab		2	1
7	SC-EAE-4	SC-479T	Global Optimization Methods	3		3
		SC-479P	Global Optimization Methods Lab		2	1
7	SC-EAE-5	SC-481T	Soft Computing and Expert Systems	3		3
		SC-481P	Soft Computing and Expert Systems Lab		2	1

Emerging Area Specialization: Machine Learning & Data Analytics (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	MLDA-EAE-1	DA-304T	Statistics, Statistical Modelling & Data Analytics	3		3
		DA-304P	Statistics, Statistical Modelling & Data Analytics Lab		2	1
6	MLDA-EAE-2A OR	DA-338T	Data Analytics	3		3
		DA-338P	Data Analytics Lab		2	1
	MLDA-EAE-2B OR	DS-340T	Data Visualization	3		3
		DS-340P	Data Visualization Lab		2	1
	MLDA-EAE-2C	ML-342T	Machine Learning	3		3
		ML-342P	Machine Learning Lab		2	1
7	MLDA-EAE-3	ML-463T	Supervised and Deep Learning	3		3
		ML-463P	Supervised and Deep Learning Lab		2	1
7	MLDA-EAE-4	ML-465T	Unsupervised Learning	3		3
		ML-465P	Unsupervised Learning Lab		2	1
7	MLDA-EAE-5A OR	ML-467T	Machine Learning and Data Analytics Case Studies	3		3
		ML-467P	Machine Learning and Data Analytics Case Studies Lab		2	1
	MLDA-EAE-5B	ML-469T	Machine Learning and Data Analytics Frameworks	3		3
		ML-469P	Machine Learning and Data Analytics Frameworks Lab		2	1

Emerging Area Specialization: Software Engineering (for CSE / IT / CST / ITE / CS)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	SE-EAE-1	SE-350T	Software Measurements, Metrics and Modelling	3		3
		SE-350P	Software Measurements, Metrics and Modelling Lab		2	1
6	SE-EAE-2A OR	SE-352T	Service Oriented Architecture	3		3
		SE-352P	Service Oriented Architecture Lab		2	1
	SE-EAE-2B	SE-354T	Software Project Management	3		3
		SE-354P	Software Project Management Lab		2	1
7	SE-EAE-3	SE-483T	Mining Software Repositories and Predictive Modelling	3		3
		SE-483P	Mining Software Repositories and Predictive Modelling Lab		2	1
7	SE-EAE-4A OR	SE-485	Software Security	4		4
	SE-EAE-4B	SE-487T	Software Verification, Validation and Testing	3		3
		SE-487P	Software Verification, Validation and Testing Lab		2	1
7	SE-EAE-5	SE-489	Software Engineering Standards	4		4

Emerging Area Specialization: Full Stack Development (for CSE / IT / CST / ITE / CS)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	FSD-EAE-1	FSD-318T	Advanced Java Programming	3		3
		FSD-318P	Advanced Java Programming Lab		2	1
6	FSD-EAE-2A OR	FSD-320T	Web Development using MEAN Stack	3		3
		FSD-320P	Web Development using MEAN Stack Lab		2	1
	FSD-EAE-2B	FSD-322T	Web Development using MERN Stack	3		3
		FSD-322P	Web Development using MERN Stack Lab		2	1
7	FSD-EAE-3	FSD-435T	PHP Programming and MySQL	3		3
		FSD-435P	PHP Programming and MySQL Lab		2	1
7	FSD-EAE-4	FSD-437T	Mobile App Development	3		3
		FSD-437P	Mobile App Development Lab		2	1
7	FSD-EAE-5	FSD-439T	Web and Mobile Application Testing and Deployment	3		3
		FSD-43P	Web and Mobile Application Testing and Deployment Lab		2	1

Emerging Area Specialization: Image Processing and Computer Vision (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	IPCV-EAE-1A OR	IPCV-334T	Digital Image Processing	3		3
		IPCV-334P	Digital Image Processing Lab		2	1
	IPCV-EAE-1B	IPCV-356T	Digital Signal and Image Processing	3		3
		IPCV-356P	Digital Signal and Image Processing Lab		2	1
6	IPCV-EAE-2	IPCV-336T	Pattern Recognition	3		3
		IPCV-336P	Pattern Recognition Lab		2	1
7	IPCV-EAE-3	IPCV-451T	Computer Vision	3		3
		IPCV-451P	Computer Vision Lab		2	1
7	IPCV-EAE-4A OR	IPCV-453T	Biometrics	3		3
		IPCV-453P	Biometrics Lab		2	1
	IPCV-EAE-4B OR	IPCV-455T	Medical Image Processing, Analysis and Reconstruction	3		3
		IPCV-455P	Medical Image Processing, Analysis and Reconstruction Lab		2	1
	IPCV-EAE-4C	IPCV-457T	Remote Sensing Image Analysis and Classification	3		3
		IPCV-457P	Remote Sensing Image Analysis and Classification Lab		2	1
7	IPCV-EAE-5A OR	IPCV-459T	Deep Learning for Image Processing and Computer Vision	3		3
		IPCV-459P	Deep Learning for Image Processing and Computer Vision Lab		2	1
	IPCV-EAE-5B	IPCV-461T	Machine Learning for Image and Vision Analysis	3		3
		IPCV-461P	Machine Learning for Image and Vision Analysis Lab		2	1

Emerging Area Specialization: Embedded Systems (for CSE/IT/CST/ITE/CS/ECE/EE/EEE /ICE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	ES-EAE-1A OR	ES-302T	Microprocessors and Interfacing	3		3
		ES-302P	Microprocessors and Interfacing Lab		2	1
	ES-EAE-1B OR	ES-308T	Introduction to Data Communication and Networking	3		3
		ES-308P	Introduction to Data Communication and Networking Lab		2	1
	ES-EAE-1C	ES-310T	Advanced Microprocessors (ARM) & Interfacing	3		3
		ES-310P	Advanced Microprocessors (ARM) & Interfacing Lab		2	1
6	ES-EAE-2A OR	ES-304	Real Time Operating Systems	4		4
	ES-EAE-2B	ES-306T	Embedded System Architecture and Design	3		3
		ES-306P	Embedded System Architecture and Design Lab		2	1
7	ES-EAE-3A OR	ES-401T	Programming in C for Embedded Systems	3		3
		ES-401P	Programming in C for Embedded Systems Lab		2	1
	ES-EAE-3B	ES-403T	VHDL Programming	3		3
		ES-403P	VHDL Programming Lab		2	1
7	ES-EAE-4	ES-405T	Real Time Embedded System Programming	3		3
		ES-405P	Real Time Embedded System Programming Lab		2	1
7	ES-EAE-5A OR	ES-407T	Embedded Linux	3		3
		ES-407P	Embedded Linux Lab		2	1
	ES-EAE-5B OR	IOT-409T	Introduction to Sensors and Transducers	3		3
		IOT-409P	Introduction to Sensors and Transducers Lab		2	1
	ES-EAE-5C	ES-411T	Logic Design and Analysis using Verilog	3		3
		ES-411P	Logic Design and Analysis using Verilog Lab		2	1

Open Area Elective (OAE) Groups (for Minor Specialization)

The minor specialization is offered through a set of five papers that the student has to study to acquire the minor specialization. The number of papers to be studied is two in 6th semester and three in 7th semester. The minor specialization shall be awarded if and only if 20 credits are earned from an individual / specific minor specialization area. From each paper group associated with a paper paper slot in a particular semester, the student shall be allowed to study only one paper group. The papers shall be allowed to be taken / studied by the students, by the APC of the department / institute, keeping in view that two papers studied by the student should not have a substantial overlap. All papers studied by the student should be substantially distinct in content.

Minor specialization is not necessary for award of the degree, the student may choose five papers from the groups offered by the institution to a particular student (belonging to a major discipline) across groups. Minimum two minor specialization groups should be offered by the institution to students of any particular major discipline from either of the open area or emerging area groups.

An elective shall be offered to the student for each Minor Specialization group in Open Area (That is for OAE-1, OAE-2, etc.) based on the availability of resources and faculty at the institution and at least one third of the batch or at least 20 students must be willing to take the elective.

Each OAE slot is of 4 credits, if in a particular slot, the paper has no practical component, then it is of 4 credits (a pure theory paper), otherwise for purpose of examination and conduct of classes, the course is split in two papers, namely a theory paper of 3 credits and a practical paper of 1 credit. The student has to study for 4 credits per slot of OAE group. This is reflected by suffixing the paper code by T (for Theory component) and P (for Practical component), if required. The nomenclature of the paper group is <ACRONYM OF EMERGING AREA> - OAE - <SLOT NUMBER><A or B or C etc., if required>. The major disciplines to which the open Area Elective Group papers can be offered is specified as acronym together with the name of the minor specialization.

In lieu of Open Area Elective, students can study papers from Emerging Area Elective groups also as offered to them.

The Open Area Electives described / enumerated are the one offered by engineering departments. If other departments, offering minor specialization or elective papers as Open Area Electives to engineering students (approved by the University Academic Council) are possible at the concerned institution, the same may also be offered to the engineering students studying in the major disciplines under the aegis of the University School of Information, Communication and Technology. The APC of the department / intuition shall allow the choice of such electives, provided they follow the credit framework of the programme of study for Open Area Electives.

Open Area Specialization: Electronics and Communications Engineering (for CSE / IT / CST / ITE / CS / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	ECE-OAE-1AOR	OECE-312T	Introduction to Circuits and Systems	3		3
		OECE-312P	Introduction to Circuits and Systems Lab		2	1
	ECE-OAE-1B	OECE-344T	Introduction to Analog Electronics	3		3
		OECE-344P	Introduction to Analog Electronics Lab		2	1
6	ECE-OAE-2	OECE-314T	Electronic Devices and Circuits	3		3
		OECE-314P	Electronic Devices and Circuits Lab		2	1
7	ECE-OAE-3A OR	OECE-415	Digital Logic and Computer Design	4		4
	ECE-OAE-3B	OECE-417T	Microprocessors and Interfacing	3		3
		OECE-417P	Microprocessors and Interfacing Lab		2	1
7	ECE-OAE-4A OR	OECE-419T	Analog and Digital Communications	3		3
		OECE-419P	Analog and Digital Communications Lab		2	1
	ECE-OAE-4B	OECE-421T	Wireless Sensor Networks	3		3
		OECE-421P	Wireless Sensor Networks Lab		2	1
7	ECE-OAE-5A OR	OECE-423	Control Systems	4		4
	ECE-OAE-5B	OECE-425T	Introduction to Computer Networks	3		3
		OECE-425P	Introduction to Computer Networks Lab		2	1

Open Area Specialization: Electrical Engineering (for CSE / IT / CST / ITE / CS / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	EE-OAE-1A OR	OEE-316T	Introduction to Circuits and Systems	3		3
		OEE-316P	Introduction to Circuits and Systems Lab		2	1
	EE-OAE-1B	OEE-346T	Introduction to Analog Electronics	3		3
		OEE-346P	Introduction to Analog Electronics Lab		2	1
6	EE-OAE-2	OEE-318T	Introduction to Electrical Machines	3		3
		OEE-318P	Introduction to Electrical Machines Lab		2	1
7	EE-OAE-3	OEE-427T	Control Systems for Electrical Engineering	3		3
		OEE-427P	Control Systems for Electrical Engineering Lab		2	1
7	EE-OAE-4	OEE-429T	Generation, Transmission and Distribution	3		3
		OEE-429P	Generation, Transmission and Distribution Lab		2	1
7	EE-OAE-5	OEE-431T	Introduction to Power Electronics	3		3
		OEE-431P	Introduction to Power Electronics Lab		2	1

Open Area Specialization: Software Development (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	SD-OAE-1A OR	OSD-328T	C++ Programming	3		3
		OSD-328P	C++ Programming Lab		2	1
	SD-OAE-1B OR	OSD-330T	Programming in Windows Environment	3		3
		OSD-330P	Programming in Windows Environment Lab		2	1
	SD-OAE-1C	OSD-332T	Programming in Java	3		3
		OSD-332P	Programming in Java Lab		2	1
6	SD-OAE-2A OR	OSD-334T	Android App Development	3		3
		OSD-334P	Android App Development Lab		2	1
	SD-OAE-2B	OSD-336T	Introduction to Database Management Systems	3		3
		OSD-336P	Introduction to Database Management Systems Lab		2	1
7	SD-OAE-3A OR	OSD-445T	Data Structures and Algorithms	3		3
		OSD-445P	Data Structures and Algorithms Lab		2	1
	SD-OAE-3B	OSD-447T	Project Management	3		3
		OSD-447P	Project Management Lab		2	1
7	SD-OAE-4A OR	OSD-449T	Design Patterns	3		3
		OSD-449P	Design Patterns Lab		2	1
	SD-OAE-4B	OSD-451T	Introduction to Software Engineering	3		3
		OSD-451P	Introduction to Software Engineering Lab		2	1
7	SD-OAE-5A OR	OSD-453T	Advanced Java Programming	3		3
		OSD-453P	Advanced Java Programming Lab		2	1
	SD-OAE-5B	OSD-455T	Programming in Linux Environment	3		3
		OSD-455P	Programming in Linux Environment Lab		2	1

Open Area Specialization: Mechanical Engineering (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	ME-OAE-1	OME-324T	Theory of Machines	3		3
		OME-324P	Theory of Machines Lab		2	1
6	ME-OAE-2	OME-326T	Materials and Machine Technology	3		3
		OME-326P	Materials and Machine Technology Lab		2	1
7	ME-OAE-3	OME-439T	Fluids and Thermal Engineering	3		3
		OME-439P	Fluids and Thermal Engineering Lab		2	1
7	ME-OAE-4	OME-441T	Mechanics and Design of Solids	3		3
		OME-441P	Mechanics and Design of Solids Lab		2	1
7	ME-OAE-5	OME-443T	Automation in Manufacturing	3		3
		OME-443P	Automation in Manufacturing Lab		2	1

Open Area Specialization: Instrumentation and Control Engineering (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	ICE-OAE-1	OICE-320T	Introduction to Sensors and Transducers	3		3
		OICE-320P	Introduction to Sensors and Transducers Lab		2	1
6	ICE-OAE-2	OICE-322T	Measurement and Control	3		3
		OICE-322P	Measurement and Control Lab		2	1
7	ICE-OAE-3	OICE-433	Process Control	4		4
7	ICE-OAE-4	OICE-435T	Introduction to Industrial Instrumentation	3		3
		OICE-435P	Introduction to Industrial Instrumentation Lab		2	1
7	ICE-OAE-5	OICE-437T	Bio Medical Instrumentation	3		3
		OICE-437P	Bio Medical Instrumentation Lab		2	1

Open Area Specialization: Civil Engineering (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE / ME)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	CE-OAE-1	OCE-302	Structural Analysis and Design	4		4
6	CE-OAE-2	OCE-304	Pipe and Open Channel Hydraulics	4		4
7	CE-OAE-3	OCE-401	Green Building Construction Materials and Practices	4		4
7	CE-OAE-4	OCE-403	Public Health Engineering	4		4
7	CE-OAE-5	OCE-405	Geotechnical and Transportation Engineering	4		4

Open Area Specialization: Universal Human Values (for CSE / IT / CST / ITE / CS / ECE / EE / EEE / ICE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	UHV-OAE-1	OUHV-338	Understanding Human Being, Nature and Existence Comprehensively	4		4
6	UHV-OAE-2	OUHV-340	Vision for Humane Society	4		4
7	UHV-OAE-3A OR	OUHV-457	Human Values and Madhyasth Darshan	4		4
	UHV-OAE-3B OR	OUHV-459	Human Values in Buddh and Jain Darshan	4		4
	UHV-OAE-3C	OUHV-461	Human Values in Vedic Darshan (Sankhya, Yoga and Vedanta)	4		4
7	UHV-OAE-4A OR	OUHV-463	Holistic Human Health	4		4
	UHV-OAE-4B	OUHV-465	Human Sociology	4		4
7	UHV-OAE-5	OUHV-467	Human Economics	4		4

Syllabus of 1st Year Onward Papers

The syllabus of the following papers / subjects is described in the subsequent pages:

S.No.	Semester	Paper Code	Paper Name
1.	4	CIC-214	Operating Systems
2.	4	CIC-216	Computer Networks
3.	4	CIC-218	Functional and Logic Programming
4.	4	CIC-260	Operating Systems Lab
5.	4	CIC-262	Computer Networks Lab
6.	4	CIC-264	Functional and Logic Programming Lab
7.	5	CIC-315	Database Management Systems
8.	5	CIC-317	Programming in Java
9.	5	CIC-367	Database Management Systems Lab
10.	5	CIC-369	Programming in Java Lab
11.	6	CIE-376T	Computer Graphics
12.	6	CIE-376P	Computer Graphics Lab
13.	6	CIE-378	Complexity Theory
14.	7	CIE-433T	Software Verification, Validation and Testing
15.	7	CIE-433P	Software Verification, Validation and Testing Lab
16.	7	CIE-435T	Network Programming
17.	7	CIE-435P	Network Programming Lab

However, the syllabus of rest of the papers / subjects shall be refered from **Part – I** using the Paper Code of the respestive paper / subject.

Operating Systems	**L**	**P**	**C**
	4		**4**

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	4	PC	PC	CIC-214
CSE/IT/CST/ITE	5	PC	PC	CIC-305
OAE	7	CSE-OAE	CSE-OAE-4	OCSE-409

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 20 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand the basics of OS and their functions. To learn the scheduling policies of various operating systems.
2.	Learn memory management methods.
3.	To understand the characterisation of deadlock, system deadlock, preventing deadlock, avoiding deadlock and related concepts.
4.	To understand the meaning of a file, structure of the directories, file structure system and implementation, free-space management

Course Outcomes (CO)

CO 1	Understand the role of operating system in a computing device, and Ability to understand paging and segmentation methods of memory binding and their pros & cons.
CO 2	Understand scheduling of process over a processor. Ability to use concepts of semaphore and its usage in process synchronization.
CO 3	Ability to synchronize programs and make the system deadlock free.
CO 4	Ability to understand file system like file access methods, directory structures, file space allocation in disk and free space management in disk. Ability to understand disk scheduling and disk recovery procedures.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	2	-	3	-	-	-	-	-	-	-
CO 2	3	3	-	-	2	-	-	-	-	-	-	-
CO 3	3	2	3	-	2	-	-	-	-	-	-	-
CO 4	3	3	-	-	2	-	-	-	-	-	-	-

UNIT-I

Introduction: What is an Operating System, Simple Batch Systems, Multiprogrammed Batches systems, Time Sharing Systems, Personal-computer systems, Parallel systems, Distributed Systems, Real-Time Systems, OS – A

Resource Manager.
Processes: Introduction, Process states, process management, Interrupts, Interprocess Communication Threads: Introduction, Thread states, Thread Operation, Threading Models. Processor Scheduling: Scheduling levels, preemptive vs no preemptive scheduling, priorities, scheduling objective, scheduling criteria, scheduling algorithms, demand scheduling, real time scheduling.

UNIT-II

Process Synchronization: Mutual exclusion, software solution to Mutual exclusion problem, hardware solution to Mutual exclusion problem, semaphores, Critical section problems. Case study on Dining philosopher problem, Barber shop problem etc.
Memory Organization & Management: Memory Organization, Memory Hierarchy, Memory Management Strategies, Contiguous versus non- Contiguous memory allocation, Partition Management Techniques, Logical versus Physical Address space, swapping, Paging, Segmentation, Segmentation with Paging Virtual Memory: Demand Paging, Page Replacement, Page-replacement Algorithms, Performance of Demand Paging, Thrashing, Demand Segmentation, and Overlay Concepts.

UNIT-III

Deadlocks: examples of deadlock, resource concepts, necessary conditions for deadlock, deadlock solution, deadlock prevention, deadlock avoidance with Bankers algorithms, deadlock detection, deadlock recovery.
Device Management: Disk Scheduling Strategies, Rotational Optimization, System Consideration, Caching and Buffering.

UNIT - IV

File System: Introduction, File Organization, Logical File System, Physical File System, File Allocation strategy, Free Space Management, File Access Control, Data Access Techniques, Data Integrity Protection, Case study on file system viz FAT32, NTFS, Ext2/Ext3 etc.

Textbook(s):
1. Deitel & Dietel, “Operating System”, Pearson, 3 rd Ed., 2011
2. Silbersachatz and Galvin, “Operating System Concepts”, Pearson, 5th Ed., 2001
3. Madnick & Donovan, “Operating System”, TMH,1st Ed., 2001

References:
1. Tannenbaum, “Operating Systems”, PHI, 4th Edition, 2000
2. Godbole, “Operating Systems”, Tata McGraw Hill, 3rd edition, 2014
3. Chauhan, “Principles of Operating Systems”, Oxford Uni. Press, 2014
4. Dhamdhere, “Operating Systems”, Tata McGraw Hill, 3rd edition, 2012
5. Loomis, “Data Management & File Structure”, PHI, 2nd Ed.

Operating Systems Lab	**L**	**P**	**C**
		2	**1**

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	4	PC	PC	CIC-260
CSE/IT/CST/ITE	5	PC	PC	CIC-353

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Operating Systems) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Write a program to implement CPU scheduling for first come first serve.
2. Write a program to implement CPU scheduling for shortest job first.
3. Write a program to perform priority scheduling.
4. Write a program to implement CPU scheduling for Round Robin.
5. Wite a program for page replacement policy using a) LRU b) FIFO c) Optimal.
6. Write a program to implement first fit, best fit and worst fit algorithm for memory management.
7. Write a program to implement reader/writer problem using semaphore.
8. Write a program to implement Producer-Consumer problem using semaphores.
9. Write a program to implement Banker's algorithm for deadlock avoidance.
10. Write C programs to implement the various File Organization Techniques

Computer Networks	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	4	PC	PC	CIC-216
CSE/IT/CST/ITE	5	PC	PC	CIC-307
ICE	5	PC	PC	CIC-313

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 20 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	ild an understanding of the fundamental concepts of computer networking.
2.	Familiarize the student with the basic taxonomy and terminology of the computer networking area.
3.	Introduce the student to advanced networking concepts, preparing the student for entry Advanced courses in computer networking.
4.	Allow the student to gain expertise in some specific areas of networking such as the design and maintenance of individual networks.

Course Outcomes (CO)

CO 1	Understand basic computer network technology.
CO 2	Understand and explain Data Communications System and its components.
CO 3	Implements various network topologies and IP addressing, subnetting.
CO 4	Enumerate the layers of the OSI model and TCP/IP.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	1	1	3	1	-	-	-	-	-	3
CO 2	3	2	1	1	3	1	-	-	-	-	-	3
CO 3	3	2	1	1	3	1	-	-	-	-	-	3
CO 4	3	2	1	1	3	1	-	-	-	-	-	3

UNIT-I

Data Communications: Components, Networks, The Internet, Protocols and Standards, Network Models: The OSI Model, TCP/IP Protocol Suite , A Comparison of the OSI and TCP/IP Reference Models, Addressing, Physical Layer: Analog and Digital Signals, Transmission modes, Transmission Media: Guided Media, Unguided Media, Review of Error Detection and Correction codes.
Switching: Circuit switching (space-division, time division and space-time division), packet switching (virtual circuit and Datagram approach), message switching.

UNIT-II

Data Link Layer: Design issues, Data Link Control and Protocols: Flow and Error Control, Stop-and-wait ARQ.

Sliding window protocol, Go-Back-N ARQ, Selective Repeat ARQ, HDLC, Point-to –Point Access: PPP Point –to-Point Protocol, PPP Stack,
Medium Access Sub layer: Channel allocation problem, Controlled Access, Channelization, multiple access protocols, IEEE standard 802.3 & 802.11 for LANS and WLAN, high-speed LANs, Token ring, Token Bus, FDDI based LAN, Network Devices-repeaters, hubs, switches bridges.

UNIT-III

Network Layer: Design issues, Routing algorithms, Congestion control algorithms, Host to Host Delivery: Internetworking, addressing and routing, IP addressing (class full & Classless), Subnet, Network Layer Protocols: ARP, IPV4, ICMP, IPV6 ad ICMPV6.

UNIT - IV

Transport Layer: Process to Process Delivery: UDP; TCP, congestion control and Quality of service. Application Layer: Client Server Model, Socket Interface, Domain Name System (DNS): Electronic Mail (SMTP), file transfer (FTP), HTTP and WWW.

Textbook(s):

1. Behrouz A. Forouzan, “Data Communications and Networking”, Tata McGraw-Hill.

References:

1. A. S. Tannenbum, D. Wetherall,, “Computer Networks”, Prentice Hall, Pearson.
2. Fred Halsall, “Computer Networks”, Addison – Wesley.
3. Tomasi, “Introduction To Data Communications & Networking”, Pearson.

Computer Networks Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	4	PC	PC	CIC-262
CSE/IT/CST/ITE	5	PC	PC	CIC-355
ICE	5	PC	PC	CIC-365

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Computer Networks) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Introduction to Networking Simulation Tools: Wireshark, Cisco Packet Tracer.
2. To understand the operation of TELNET by accessing the router in server room from a PC in IT office.
3. To implement an IP Addressing Scheme and Subnetting in small networks using Cisco Packet Tracer.
4. To implement the static routing using Cisco Packet Tracer.
5. To implement the DHCP onto the Network Topology using Cisco Packet Tracer.
6. To implement the DNS, Email Services in the Network using Cisco Packet Tracer.
7. To implement the Dynamic Routing Protocols: RIP, IGRP using Cisco Packet Tracer.
8. To construct multiple router networks and implement the EIGRP Protocol.
9. To implement the Network Address Resolution (NAT) using Cisco Packet Tracer.
10. Conducting a Network Capture and Monitoring with Wireshark Simulation Tool.

Functional and Logic Programming	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	4	PC	PC	CIC-218

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions for paper setter:
1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 20 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand the concepts of functional programming paradigm.
2.	To solve problems using Haskell based on functional programming.
3.	To learn logic programming and its associated concepts.
4.	To write programs using Prolog based on logic programming.

Course Outcomes (CO)

CO 1	Ability to understand the concepts of functional programming paradigm.
CO 2	Ability to solve problems using Haskell based on functional programming.
CO 3	Ability to learn logic programming and its associated concepts.
CO 4	Ability to write programs using Prolog based on logic programming.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	2	2	3	-	-	-	3	2	2	3
CO 2	3	2	2	2	3	-	-	-	3	2	2	3
CO 3	3	2	2	2	3	-	-	-	3	2	2	3
CO 4	3	2	2	2	3	-	-	-	3	2	2	3

UNIT-I

Introduction to functional programming; Getting started with Haskell and GHCi; Basic types and definitions; Designing and writing programs; Data types, tuples and lists; Input / output; Control Structures
Lambda calculus: Syntax, conversions, normal forms, Church-Rosser theorem, combinators. Implementation issues: Graph reduction, Three Instruction Machine.

UNIT-II

Programming with lists; Building vocubalary; Defining functions over lists; Pattern matching and recursion; Overloading, type classes and type checking; Algebraic types

UNIT-III

Introduction to logic programming; Basic constructs; database programming; Recursive programming; The computation model of logic programs; Theory of logic programs; Applications of logic programming

UNIT - IV

Prolog language: Introduction, Programming in Prolog, Arithmetic, Structure inspection. Second Order Programming, Logic grammars, Search techniques
.

Textbook(s):

1. Thompson, Haskell: The Craft of Functional Programming, 2nd Edition, Addison- Wesley, 1999.
2. L. Stirling and E. Shapiro, The Art of Prolog: Advanced Programming Techniques, 2nd Ed, MIT Press, 1994.

References:

1. L. Peyton Jones, The Implementation of Functional Programming Languages, Prentice Hall, International Series in Computer Science, 1987.
2. C. Reade, Elements of Functional Programming, Addison-Wesley, 1989.
3. H. Barendregt, The Lambda Calculus: Its Syntax and Semantics, North Holland, 1984.
4. J. W. Lloyd, Foundations of Logic Programming, Springer Verlag, 1987.

Functional and Logic Programming Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	4	PC	PC	CIC-264

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Functional and Logic Programming) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Installation and study of Haskell
2. Defining and using user-defined functions
3. Pattern matching and recursion
4. List processing
5. Using functions and list operators
6. Type classes and user-defined data types
7. Installation and study of Prolog
8. Program to categorise animal characteristics.
9. Program to demonstrate family relationship.
10. Program to show how integer variable is used in prolog program .

Database Management Systems	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE/IT/CST/ITE	4	PC	PC	CIC-210
CS	5	PC	PC	CIC-315

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions for paper setter:
1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 20 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To introduce basic concepts, architecture and characteristics of database systems
2.	To introduce relational model concepts and PL/SQL programming
3.	To introduce relational database design and Normal forms based on functional dependencies
4.	To introduce concepts of object oriented & distributed databases

Course Outcomes (CO) :

CO 1	Ability to understand advantages of database systems
CO 2	Ability to use SQL as DDL, DCL and DML
CO 3	Ability to design database and manage transaction processing
CO 4	Understand object oriented & distributed databases systems and use them

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	2	2	2	-	-	-	3	2	2	3
CO 2	3	3	2	2	2	-	-	-	3	2	2	3
CO 3	3	3	2	3	3	-	-	-	3	2	2	3
CO 4	3	3	2	3	3	-	-	-	3	2	2	3

UNIT – I

Basic concepts: database & database users, characteristics of the database systems, concepts and architecture, date models, schemas & instances, DBMS architecture & data independence, database languages & interfaces, data modelling using the entity-relationship approach. Enhanced ER concepts - Specialization/Generalization, Aggregation, Mapping of ER model to Relational Model.
SQL – DDL, DCL & DML views and indexes in SQL. Basics of SQL, DDL, DML,DCL, structure – creation, alteration, defining constraints – Primary key, foreign key, unique, not null, check, IN operator.

UNIT - II:

Relational model concepts, relational model constraints, relational algebra, relational calculus.
SQL – Functions - aggregate functions, Built-in functions – numeric, date, string functions, set operations, sub-queries, correlated sub-queries, Use of group by, having, order by, join and its types, Exist, Any, All , view and its types. Transaction control commands – Commit, Rollback, Save point.

UNIT - III

Relational data base design: functional dependencies & normalization for relational databases, normal forms based on functional dependencies, (1NF, 2NF, 3NF & BCNF), lossless join and dependency preserving decomposition, normal forms based on multivalued & join dependencies (4NF & 5NF) & domain key normal form

Properties of Transaction, Transaction states, Transaction Schedule, Serializability, Concurrency control techniques, locking techniques, time stamp ordering, Recoverable schedules, granularity of data items, Deadlock detection and Recovery, recovery techniques: recovery concepts, database backup and recovery from catastrophic failures.
Database Programming – control structures, exception handling, stored procedures, Triggers.

UNIT - IV

File Structures and Indexing: Secondary Storage Devices, Operations on Files, Heap Files, Sorted Files, Hashing, Single level indexes, Multi-level indexes, B and B+ tree indexes.
Concepts of Object Oriented Database Management systems & Distributed Database Management Systems

Textbooks:
1. R. Elmsari and S. B. Navathe, “Fundamentals of database systems”, Pearson Education, 7th Edition, 2018
2. V. M. Grippa and S. Kumichev, “Learning MySQL”, O’Reilly, 2021.
3. SQL/ PL/SQL, The programming language of Oracle, Ivan Bayross, 4th Edition BPB Publications

References:
1. A. Silberschatz, H. F. Korth and S. Sudershan, “Database System Concept”, McGraw Hill, 6th Edition,2013.
2. Date, C. J., “An introduction to database systems”, 8th Edition, Pearson Education, 2008.
3. P. Rob & C. Coronel, “Database Systems: Design Implementation & Management”, Thomson Learning, 6th Edition, 2004
4. Desai, B., “An introduction to database concepts”, Galgotia publications, 2010
5. H. Garcia-Molina, J. D. Ullman, J. Widom, “Database System: The Complete Book”, PH.
6. Joel Murach, Murach's Mysql””, 3rd Edition-Mike Murach and Associates, Incorporated, 2019.
7. Oracle and MySQL manuals.

Database Management Systems Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE/IT/CST/ITE	4	PC	PC	CIC-256
CS	5	PC	PC	CIC-367

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Database Management Systems) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Experiments based on DDL commands – CREATE, ALTER, DROP and TRUNCATE.
2. Apply the integrity constraints like Primary Key, Foreign key, Check, NOT NULL, etc. to the tables.
3. Experiments based on basic DML commands – SELECT, INSERT, UPDATE and DELETE.
4. Write the queries for implementing Built-in functions, GROUP BY, HAVING and ORDER BY.
5. Write the queries to implement the joins.
6. Write the queries to implement the subqueries.
7. Write the queries to implement the set operations.
8. Write the queries to create the views and queries based on views.
9. Demonstrate the concept of Control Structures.
10. Demonstrate the concept of Exception Handling.
11. Demonstrate the concept of Functions and Procedures.
12. Demonstrate the concept of Triggers.

Programming in Java	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE/IT/CST/ITE	4	PC	PC	CIC-212
CS	5	PC	PC	CIC-317

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 20 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand and gain knowledge of characteristics of Java, JVM, instruction set, control flow, programming and the sandbox model.
2.	To learn the Java programming, use of exceptional handling and inheritance.
3.	To understand threads, thread synchronization, AWT components and event handling mechanism.
4.	To understand the concepts of I/O streams, JDBC, object serialization, sockets, RMI, JNI, Collection API interfaces, Vector, Stack, Hash table classes, list etc.

Course Outcomes (CO)

CO 1	Ability to understand the compilation process of Java, role of JVM as an emulator and various types of instructions.
CO 2	Ability to learn and apply concepts of Java programming, exceptional handling and inheritance.
CO 3	Ability to understand the use of multi-threading, AWT components and event handling mechanism in Java.
CO 4	Ability to understand the concepts of I/O streams, IDBC, object serialization, sockets, RMI, JNI, Collection API interfaces, Vector, Stack, Hash table classes, list etc.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	2	2	3	-	-	-	3	2	2	3
CO 2	3	2	2	2	3	-	-	-	3	2	2	3
CO 3	3	2	2	2	3	-	-	-	3	2	2	3
CO 4	3	2	2	2	3	-	-	-	3	2	2	3

UNIT - I

Overview and characteristics of Java, Java program Compilation and Execution Process Organization of the Java Virtual Machine, JVM as an interpreter and emulator, Instruction Set, class File Format, Verification, Class Area, Java Stack, Heap, Garbage Collection. Security Promises of the JVM, Security Architecture and Security Policy. Class loaders and security aspects, sandbox model

UNIT - II

Java Fundamentals, Data Types & Literals Variables, Wrapper Classes, Arrays, Arithmetic Operators, Logical

Operators, Control of Flow, Classes and Instances, Class Member Modifiers Anonymous Inner Class Interfaces and Abstract Classes, inheritance, throw and throws clauses, user defined Exceptions, The String Buffer Class, tokenizer, applets, Life cycle of applet and Security concerns.

UNIT - III

Threads: Creating Threads, Thread Priority, Blocked States, Extending Thread Class, Runnable Interface, Starting Threads, Thread Synchronization, Synchronize Threads, Sync Code Block, Overriding Synced Methods, Thread Communication, wait, notify and notify all.
AWT Components, Component Class, Container Class, Layout Manager Interface Default Layouts, Insets and Dimensions, Border Layout, Flow Layout, Grid Layout, Card Layout Grid Bag Layout AWT Events, Event Models, Listeners, Class Listener, Adapters, Action Event Methods Focus Event Key Event, Mouse Events, Window Event

UNIT - IV

Input/Output Stream, Stream Filters, Buffered Streams, Data input and Output Stream, Print Stream Random Access File, JDBC (Database connectivity with MS-Access, Oracle, MS-SQL Server), Object serialization, Sockets, development of client Server applications, design of multithreaded server. Remote Method invocation, Java Native interfaces, Development of a JNI based application.
Collection API Interfaces, Vector, stack, Hashtable classes, enumerations, set, List, Map, Iterators.

Textbook(s):
1. Patrick Naughton and Herbertz Schidt, “Java-2 the Complete Reference”,TMH

References:
1. E. Balaguruswamy, “Programming with Java”, TMH
2. Horstmann, “Computing Concepts with Java 2 Essentials”, John Wiley.
3. Decker & Hirshfield, “Programming Java”, Vikas Publication.

Programming in Java Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE/IT/CST/ITE	4	PC	PC	CIC-258
CS	5	PC	PC	CIC-369

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Programming in Java) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Write a java program to implement stack and queue concept.
2. Write a java program to produce the tokens from given long string.
3. Write a java package to show dynamic polymorphism and interfaces.
4. Write a java program to show multithreaded producer and consumer application.
5. Create a customized exception and also make use of all the 5 exception keywords.
6. Convert the content of a given file into the uppercase content of the same file.
7. Write a program in java to sort the content of a given text file.
8. Develop an analog clock using applet.
9. Develop a scientific calculator using swings.
10. Create an editor like MS-word using swings.
11. Create a servlet that uses Cookies to store the number of times a user has visited your servlet.
12. Create a simple java bean having bound and constrained properties.

Computer Graphics	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	6	PCE	PCE-2	CIE-376T

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions for paper setter:
1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 20 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To introduce fundamentals of computer graphics, types of graphics and Raster graphics algorithms
2.	To introduce geometric manipulation in 2D and 3D space, perspective projections, surface and solid modelling.
3.	To understand Color models and various illumination models
4.	To understand Rendering techniques and Advanced modelling techniques

Course Outcomes (CO)

CO 1	Ability to understand the usage of the computer graphics primitives and perform the operations on it like clipping etc.
CO 2	Ability to perform any editing of operations on geometry of the objects through 2D and 3D transformations as per the requirements and should be able to model curves and surfaces using different techniques.
CO 3	Ability to make the model appearance realistic in terms of desired color, material and final appearance calculations.
CO 4	Ability to understand the concepts of different rendering techniques and advanced modelling techniques.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	2	2	2	-	-	-	2	2	1	3
CO 2	3	2	2	2	2	-	-	-	2	2	1	3
CO 3	3	2	2	2	2	-	-	-	2	2	1	3
CO 4	3	2	2	2	2	-	-	-	2	2	1	3

UNIT - I

Introduction to graphics and types of graphics, quality parameters of graphics display. Basic raster graphics algorithms for drawing 2 D primitives: DDA line, Bresenham's line, Bresenham's circle, midpoint circle, midpoint ellipse. Conic Sections, Clipping of line (Cohen Sutherland algorithm), clipping of polygon (Sutherland Hodgeman algorithm), polygon filling. Attributes of Output primitives, Antialiasing

UNIT - II

Geometric manipulation in 2D and 3D space, window to viewport transformations, homogeneous coordinates,

projections: parallel and perspective projections.
Generating curves like Hermite, Bezier and B-spline. Surface generation, wireframe, surface and solid modelling. 3-D polygon surfaces, polygon tables, polygon meshes.

UNIT - III

Visible surface determination techniques for visible surface determination: Z-buffer, A- buffer algorithm, scanline algorithm, area subdivision algorithm for implementation of hidden surface removal. Achromatic and hardware color models and software color models. Local and global illumination models calculations, Lambert, Gouraud & Phong shading techniques.

UNIT - IV

Rendering: introduction to ray casting, ray-tracing, recursive ray tracing, and shadows. Advanced procedural modelling: fractals, concept of fractals generation, concept of grammar-based modelling.

Textbooks:

1. D. D. Hearn, M.P. Baker, "Computer Graphics C version", Pearson Education India, 2nd Edition, 2002.
2. J.D. Foley et. al., "Computer Graphics Principles & Practice in C", Pearson Education India, 2nd Edition, 2006.

References:

1. R.H. Bartels, J.C. Beatty and B.A. Barsky, "An Introduction to Splines for use in Computer Graphics and Geometric Modeling", Morgan Kaufmann Publishers Inc., 1996.
2. W. M. Newman and R. F. Sproul, "Principles of Interactive Computer Graphics", McGraw-Hill, 2nd Ed, 2001.
3. Z. Xiang and R. Plastock, "Theory and Problems of Computer Graphics", Schaum's Series, McGraw Hill, 2nd Edition, 2017.
4. F.P. Preparata and M.I. Shamos, "Computational Geometry: An Introduction", Springer, Reprint of the original 1st ed. 1985 Edition, 2012.
5. D. Rogers and J. Adams, "Mathematical Elements for Computer Graphics", McGraw Hill Education, 2nd Edition, 2017.
6. David F. Rogers, "Procedural Elements for Computer Graphics", McGraw Hill Education, 2nd Edition, 2017.
7. Alan Watt and Mark Watt, "Advanced Animation and Rendering Techniques", Addison-Wesley, 2002.

Computer Graphics Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	6	PCE	PCE-2	CIE-376P

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Computer Graphics) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Setting the VC++ environment for OpenGL
2. Introduction to OpenGL – Objectives, how does it work, Architecture, OpenGL as a Renderer, OpenGL and Related APIs
3. Study of GLUT (Graphics Language Utility Toolkit)
4. Study & implement of basic graphics function defined in graphics.h
5. Study of graphics standards
6. Program for Line drawing using DDA algorithm .
7. Program for Line drawing using Bresenhams algorithm.
8. Program for Mid-Point Circle Generation algorithm .
9. Drawing Basic Graphics Primitive - Drawing Points, Drawing Lines, Drawing Polygons, Set-up Gradient Colors
10. Interactive program using Keyboard /Mouse in OpenGL.
11. Interactive program using Menu/Submenu in OpenGL.
12. Program using 2D Transformations.
13. Rotation, Scale and Translation
14. Window to Viewport transformations in C.
15. Program for Cohen Sutherland Line Clipping Algorithm.
16. Program for polygon filling using flood fill method.
17. Design an application in OpenGL.

Complexity Theory	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	6	PCE	PCE-3	CIE-378

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions for paper setter:
1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 20 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand and apply foundational concepts of complexity theory to classify problems into different complexity classes.
2.	To analyze and design algorithms with considerations for their computational complexity.
3.	To evaluate the significance of computational reductions and their role in problem-solving.
4.	To examine the implications and challenges of the P vs. NP problem on computational science.

Course Outcomes (CO)

CO 1	Understand and apply foundational concepts of complexity theory to classify problems into different complexity classes.
CO 2	Analyze and design algorithms with considerations for their computational complexity.
CO 3	Evaluate the significance of computational reductions and their role in problem-solving.
CO 4	Critically examine the implications and challenges of the P vs. NP problem on computational science.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	2	2	2	-	-	-	2	2	2	3
CO 2	3	2	2	2	2	-	-	-	2	2	2	3
CO 3	3	2	2	2	2	-	-	-	2	2	2	3
CO 4	3	2	2	2	2	-	-	-	2	2	2	3

UNIT I

Introduction to Complexity Theory: Basics of computational complexity, time and space complexity, Big-O notation, problem classification (P, NP, NP-hard, NP-complete), polynomial-time reductions.

UNIT II

Models of Computation: Turing machines and variants, non-deterministic computation, circuit complexity, random access machines, complexity of specific algorithms (sorting, searching, graph algorithms).

UNIT III

Computational Reductibility: Cook-Levin theorem, polynomial-time reductions, NP-completeness, examples of NP-complete problems (SAT, 3-SAT, CLIQUE), techniques for proving NP-completeness.

UNIT IV

P vs. NP Problem and Beyond: P vs. NP problem statement, consequences of P = NP, PSPACE and other complexity classes, introduction to complexity theory beyond polynomial time, selected advanced topics (approximation algorithms, interactive proofs).

Textbooks:

1. M. Sipser, "Introduction to the Theory of Computation," 3rd ed., Cengage Learning, 2013.
2. C. Papadimitriou, "Computational Complexity," Addison-Wesley, 1994.

References:

1. S. Arora and B. Barak, "Computational Complexity: A Modern Approach," Cambridge University Press, 2009.
2. S. Dasgupta, C. H. Papadimitriou, and U. V. Vazirani, "Algorithms," McGraw-Hill Education, 2006.
3. M. Garey and D. Johnson, "Computers and Intractability: A Guide to the Theory of NP-Completeness," W. H. Freeman, 1979.

Software Verification, Validation and Testing	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	7	PCE	PCE-4	CIE-433T
CSE-in-EA	7	OAE-CSE-EA	OAE-2	SE-487T
EAE	7	SE-EAE	SE-EAE-4B	SE-487T

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 20 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To study fundamental concepts in software testing
2.	To identify the needs of software test automation, and define and develop a test tool to support test automation
3.	To discuss various software testing issues and solutions in software unit test, integration and system testing
4.	To expose the advanced software testing topics

Course Outcomes (CO)

CO 1	Ability to apply software testing knowledge and engineering methods.
CO 2	Ability to design and conduct a software test process for a software testing project
CO 3	Ability to understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.
CO 4	Ability to understand contemporary issues in software testing, such as component-based software testing problems.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	-	3	2	2	3	-	-	3	-	-	3	2
CO 2	3	-	3	-	2	-	3	3	-	-	2	3
CO 3	3	2	-	3	3	-	-	2	3	2	-	-
CO 4	-	2	3	-	-	3	-	2	-	-	2	-

UNIT-I

Review of Software Engineering: Overview of Software Evolution, Error, Fault, Failure, Incident, Test Cases, Testing Process, Limitations of Testing, SDLC, Testing Process, Terminologies in Testing: Error, Fault, Failure, Verification, Validation, Difference Between Verification and Validation, Test Cases, Testing Suite, Test, Oracles, Impracticality of Testing All Data; Impracticality of Testing All Paths. Verification: Verification Methods, SRS Verification, Source Code Reviews, User Documentation Verification

UNIT-II

Functional Testing: Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique. Structural Testing: Control Flow Testing, Path Testing, Independent Paths, Generation of Graph from Program, Identification of Independent Paths, Cyclomatic Complexity, Data Flow Testing, Mutation Testing

Regression Testing: What is Regression Testing? Regression Test cases selection, Reducing the number of test cases, Code coverage prioritization technique. Reducing the number of test cases: Prioritization guidelines, Priority category, Scheme, Risk Analysis.

UNIT-III

Object Oriented Testing: Definition, Issues, Class Testing, Object Oriented Integration and System Testing. Testing Web Applications: Web Testing, User Interface Testing, Usability Testing, Security Testing, Performance Testing.

UNIT - IV

Software Testing Activities: Levels of Testing, Debugging, Testing techniques and their applicability, Exploratory Testing Automated Test Data Generation: Test Data, Approaches to test data generation, test data generation using genetic algorithm, Test Data Generation Tools, Software Testing Tools, and Software test Plan.

Textbook(s):

1. Yogesh Singh, “Software Testing”, Cambridge University Press, 2012
2. K.K. Aggarwal & Yogesh Singh, “Software Engineering”, New Age International Publishers, 2003.
3. Roger S. Pressman, “Software Engineering – A Practitioner’s Approach”, Fifth Edition, McGraw-Hill, 2001.

References:

1. Marc Roper, “Software Testing”, McGraw-Hill, 1994.
2. M.C. Trivedi, Software Testing & Audit, Khanna Publishing House 6. Boris Beizer, “Software System Testing and Quality Assurance”, Van Nostrand Reinhold, 1984

Software Verification, Validation and Testing Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	7	PCE	PCE-4	CIE-433P
CSE-in-EA	7	OAE-CSE-EA	OAE-2	SE-487P
EAE	7	SE-EAE	SE-EAE-4B	SE-487P

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Software Verification, Validation and Testing) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Identify system specification and design test cases for Inventory Management.
2. Design test cases for railway Reservation.
3. To determine the nature of roots of a quadratic equations, its input is triple of +ve integers (say x,y,z) and values may be from interval [1,100] the program output may have one of the following:- [Not a Quadratic equations, Real roots, Imaginary roots, Equal roots] Perform 3-2 Functional Testing.
4. To determine the type of triangle. Its input is triple of +ve integers (say x,y,z) and the values may be from interval[1,100]. The program output may be one of the following [Scalene, Isosceles, Equilateral, Not a Triangle]. Perform 3-2 Non Functional Testing.
5. To determine the nature of roots of a quadratic equations, its input is triple of +ve integers (say x,y,z) and values may be from interval [1,100] the program output may have one of the following:- [Not a Quadratic equations, Real roots, Imaginary roots, Equal roots] Perform Regression Testing.
6. Prepare defect report after executing test cases for any login form.
7. Study of Any Testing Tool. (Ex. Win Runner)
8. Study of Any Test Management Tool. (Ex. QA Complete)
9. Automate the Test cases using Test Automation tool.(Ex. using QA Complete)
10. Learn how to raise and report Bugs using Bug tracking tool. (Ex. Bugzilla,Jira using QA Complete)
11. Study of any Test Management Tool. (Ex. Test Director)

Network Programming	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	7	PCE	PCE-5	CIE-435T
CSE-NET	7	PC	PC	NET-471T
EAE	7	NET-EAE	NET-EAE-3	NET-471T

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 20 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand inter process and inter-system communication.
2.	To understand socket programming in its entirety.
3.	To understand usage of TCP/UDP / Raw sockets.
4.	To understand how to build network applications.

Course Outcomes (CO)

CO 1	To write socket API based programs.
CO 2	To design and implement client-server applications using TCP and UDP sockets.
CO 3	To analyze network programs and to use the IP addressing in networks.
CO 4	To design socket with the help of socket programming.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	3	-	2	-	3	-	1	-	3	3
CO 2	3	2	3	-	2	-	3	-	1	-	3	3
CO 3	3	2	3	-	2	-	3	-	1	-	3	3
CO 4	3	2	3	-	2	-	3	-	1	-	3	3

UNIT-I

Introduction to Network Programming: OSI model, Unix standards, TCP and UDP & TCP connection establishment and Format, Buffer sizes and limitation, standard internet services, Protocol usage by common internet application.

Sockets: Address structures, value – result arguments, Byte ordering and manipulation function and related functions Elementary TCP sockets – Socket, connect, bind, listen, accept, fork and exec function, concurrent servers. Close function and related function.

UNIT-II

TCP client server: Introduction, TCP Echo server functions, Normal startup, terminate and signal handling server process termination, Crashing and Rebooting of server host shutdown of server host. Elementary UDP sockets: Introduction UDP Echo server function, lost datagram, summary of UDP example, Lack of flow control with

UDP, determining outgoing interface with UDP. I/O Multiplexing: I/O Models, select function, Batch input, shutdown function, poll function, TCP Echo server. Socket options: getsockopt and setsockopt functions. Socket states, Generic socket option, IPV4 socket option, ICMPV6 socket option, IPV6 socket options and TCP socket options. Advanced I/O Functions-Introduction, Socket Timeouts, recv and send Functions, readv and writev Functions, recvmsg and sendmsg Functions, Ancillary Data, How Much Data Is Queued? Sockets and Standard I/O.

UNIT-III

Elementary name and Address conversions: DNS, gethost by Name function, Resolver option, Function and IPV6 support, uname function, other networking information. Daemon Processes and inetd Superserver: Introduction, syslogd Daemon, syslog Function, daemon_init Function, inetd Daemon, daemon_inetd Function Broadcasting- Introduction, Broadcast Addresses, Unicast versus Broadcast, dg_cli Function Using Broadcasting, Race Conditions Multicasting: Introduction, Multicast Addresses, Multicasting versus Broadcasting on A LAN, Multicasting on a WAN, Multicast Socket Options, mcast_join and Related Functions, dg_cli Function Using Multicasting, Receiving MBone Session Announcements, Sending and Receiving, SNTP: Simple Network Time Protocol, SNTP.

UNIT - IV

Raw Sockets-Introduction, Raw Socket Creation, Raw Socket Output, Raw Socket Input, Ping Program, Traceroute Program, An ICMP Message Daemon, Datalink Access- Introduction, BPF: BSD Packet Filter, DLPI: Data Link Provider Interface, Linux: SOCK_PACKET, libpcap: Packet Capture Library, Examining the UDP Checksum Field. Remote Login: Terminal line disciplines, Pseudo-Terminals, Terminal modes, Control Terminals, rlogin Overview, RPC Transparency Issues.

Textbook(s):

1. W. Richard Stevens, Bill Fenner and Andrew M. Rudoff, “UNIX Network Programming”, Pearson Education.
2. W. Richard Stevens, “UNIX Network Programming”, PHI.

References:

1. T Chan, “UNIX Systems Programming using C++”, PHI.
2. Graham GLASS and King abls, “UNIX for Programmers and Users”, Pearson Education.
3. M. J. Rochkind, “Advanced UNIX Programming”, Pearson Education.

Network Programming Lab	**L**	**P**	**C**
		2	**1**

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CS	7	PCE	PCE-5	CIE-435P
CSE-NET	7	PC	PC	NET-471P
EAE	7	NET-EAE	NET-EAE-3	NET-471P

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Network Programming) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Write a program to Create Sockets for Sending and Receiving data.
2. Write a program to obtain the Local & Remote Socket Address.
3. Write a program to obtain the Local & Remote Socket Address.
4. Write a program to obtain the Information about The (A) Host (B) Network (C) Protocols (D) Domains.
5. Write a program to manipulate the IP Address.
6. Write a program to write a Telnet Client.
7. Write a program to make an FTP Client.
8. Write a program to implement Web Server using sockets
9. Write a program for file access using sockets
10. Write the programs to demonstrate the usage of Advanced socket system calls like getsockopt(), setsockopt(), getpeername (), getsockname(), readv() and writev()