

SCHEME OF EXAMINATION & SYLLABI

for

Bachelor of Technology / Master of Technology (Dual Degree Programmes)

Scheme and Syllabus for

- a. Computer Science and Engineering**
- b. Computer Science and Engineering – Artificial Intelligence**
- c. Computer Science and Engineering – Data Science**
- d. Information Technology**
- e. Electronics and Communications Engineering**

Offered by
University School of Information, Communication & Technology
At
GGSIU University, Dwarka Campus



**GURU GOBIND SINGH
INDRAPRASTHA
UNIVERSITY**

Guru Gobind Singh Indraprastha University
Sector 16C, Dwarka, Delhi –110078[INDIA]
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Approval History:

1. Scheme and Syllabi of 1st year, Scheme of 2nd year, and framework of scheme of 3rd year and 4th year approved by BoS on 06.08.2024.
2. Scheme and Syllabi of 1st year, Scheme of 2nd year, and framework of scheme of 3rd year and 4th year approved by AC Sub-committee on 13.08.2024.
3. Scheme and Syllabi of 2nd year, and framework of scheme of 3rd and 4th year, and also the regulations for implementation and award of degrees approved by BoS on 28.07.2025.
4. Scheme and Syllabi of 2nd year, and framework of scheme of 3rd and 4th year, and also the regulations for implementation and award of degrees approved by Academic Council Sub-committee on 01.08.2025.
5. Scheme and Syllabi of 5th Semester approved by BOS on 08.08.2026.
6. Scheme and Syllabi of 5th Semester approved AC Sub-Committee on 19.08.2026.

Vision of the School

Create high-quality engineering and computer application professionals

Mission of the School

To serve humanity by creating professionally competent, socially sensitive engineers with high ethical values who can work as individuals or in groups in multicultural global environment.

Introduction

This document describes the curriculum of the Bachelor of Technology part of the Dual Degree (Bachelor Technology / Master of Technology) Programmes that are offered at the University School of Information ,Communication and Technology in its own campus (not at the affiliated institution of the University).In the event of any difficulty of implementation, and / or interpretation of any clause of the document, the same maybe 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.

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

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

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

- | | |
|---|------------------|
| 1. Teachers Continuous Evaluation: | 100 marks |
|---|------------------|

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:
 - 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;
 - that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions;
 - that require consideration of appropriate constraints/requirements not explicitly given in the problem statement such as cost, power requirement, durability, product life, etc.;
 - which need to be defined (modelled) within appropriate mathematical framework; and
 - 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 commitment of 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.

Course/PaperGroupCodes:

- BS: Basic Sciences
ES: Engineering Sciences
VAC: Value Added Course
AEC: Ability Enhancement Course
PC: Programme Core, that is course/ paper offered in the discipline of the programme as a compulsory paper.
PE: Programme Elective, that is elective course / paper offered in the discipline of the programme.
PCE: Programme Core Elective, that is elective course/paper offered in the discipline of the programme. May lead to minor specialization.
EAE: Emerging Area Elective offered by school. May lead to minor specialization.
OAE: Open area elective offered by others school or open / emerging area elective offered by the school / offered through SWAYAM / NPTEL MOOCs platform.
Note: The details of the papers offered by USICT as open elective/emerging area electives shall be notified later on.

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 or later shall be students admitted in the previous batch as they are admitted in later years of study. 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 of calculation of duration of study.

Programme of study shall mean Bachelor of Technology.

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

Minor Specialization: It is possible to use the electives to provide a limited specialization in some sub-areas of CSE/IT/ECE, which is called Minor specializations. It shall mean the specializations earned through the PCE, EAE or OAE route, subject to fulfilment of requirements, as shall be specified in the scheme of study for the concerned minor specialization. The details about the minor specialization offered by USICT will be notified later on.

Paper / Course shall be treated as synonyms. A paper is one unit of curriculum taught, in general, in one particular semester, having associated credits.

Acronyms:

- CSE: Computer Science and Engineering
IT: Information Technology
ECE: Electronics and Communications Engineering
CSE-AI: Computer Science and Engineering – Artificial Intelligence
CSE-DS: Computer Science and Engineering - Data Science
APC: Academic programme committee comprising of all faculty of the school and as defined in the implementation rules.
BoS: Board of Study of the school, USICT.
USICT or USICT: University School of Information, Communication and Technology.
L: Number of Lecture hours per week
P: Number of 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: No termend examination shall be held for papers marked as NUES. The evaluation shall be conducted as per the scheme of examinations as described in the scheme of study.

NOTE: THE CURRENT DOCUMENT DEFINES THE SCHEME AND SYLLABUS FOR THE FIRST 5 SEMESTER, THE SCHEME MAY CHANGE ON FINALIZATION OF THE SCHEME AND SYLLABUS OF 6th SEMESTER ONWARDS (INCLUDING IMPLEMENTATION REGULATION AND THE REGULATION FOR THE AWARD OF THE DEGREE)

Scheme

Bachelor of Technology / Master of Technology (Dual Degree Programmes)

In

- a. Computer Science and Engineering – Major Discipline**

B.Tech/M.Tech Dual Degree

First Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
ES	ES-101	Programming for Problem Solving	4	-	4
ES	ES-103/ ES-105	*Any one of the following: Basics of Electrical Engineering/ Basics of Electronics Engineering	3	-	3
BS	BS-107	Engineering Mathematics – I	4	-	4
BS	BS-109/ BS-111	*Any one of the following: Engineering Chemistry/ Engineering Physics	3	-	3
ES/ AEC	ES-113/ AEC-115	*Any one of the following: Engineering Mechanics/ Communication Skills	3	-	3
VAC	VAC-117	*Indian Constitution	2	-	2
VAC	VAC-119	**Human Values & Ethics	2	-	2
Practical/ Viva Voce					
ES	ES-151	Programming for Problem Solving Lab	-	2	1
ES	ES-153/ ES-155	*Any one of the following corresponding to the theory paper offered: Basics of Electrical Engineering Lab/ Basics of Electronics Engineering Lab	-	2	1
BS	BS-157/ BS-159	*Any one of the following corresponding to the theory paper offered: Engineering Chemistry Lab/Engineering Physics Lab	-	2	1
Total			21	6	24

Group	Code	Paper	L	P	Credits
VAC		**NSS/NCC/Cultural Clubs/Technical Society/ Technical Club/Institution's Innovation Council	-	-	2
VAC	VAC-161	***Environment Studies	-	-	0

Note: Orientation/ Student Induction program will be offered to the students, right at the start of the first semester.

* 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 school shall decide which paper to offer in which semester.

*This is an NUES paper.

**This is an NUES paper. Every student is required to complete this paper of at least 2 credits through SWAYAM / NPTEL MOOCs platform, with the approval of the Dean, USIC&T. If the student completes a course with the higher number of credits from SWAYAM / NPTEL MOOCs platform, the credits reflected in the university marksheet shall be only 2 credits. The marksheet of successfully completing the paper/course with at least 40% marks has to be submitted to the school by the end of the 6th semester (3rd year) of studies. The cost of the paper/course including its examination fee is to be borne by the student. The clearance of the paper/course is mandatory for the award of the degree. The result of this subject shall be incorporated in the 6th semester marksheet.

****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.

*****Non-credit:** Every student is required to complete an Environmental Studies paper of at least 2 credits through SWAYAM / NPTEL MOOCs platform with the approval of Dean, USICT&T. This shall be considered as a non-credit paper/course. The marksheets of successfully completing the paper/course with at least 40% marks has to be submitted to the school by the end of the 6th semester (3rd year) of studies. The cost of the paper/course including its examination fee is to be borne by the student. The clearance of the paper/course is mandatory for the award of the degree.

B.Tech/M.Tech Dual Degree

Second Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
ES	ES-102	Data Structures	4	-	4
SEC	SEC-104	Python Programming	4	-	4
ES	ES-106/ ES-108	*Any one of the following: Basics of Electrical Engineering/ Basics of Electronics Engineering	3	-	3
BS	BS-110	Engineering Mathematics – II	4	-	4
BS	BS-112/ BS-114	*Any one of the following: Engineering Physics/ Engineering Chemistry	3	-	3
ES/ AEC	ES-116/ AEC-118	*Any one of the following: Engineering Mechanics/ Communication Skills	3	-	3
Practical/ Viva Voce					
ES	ES-152	Data Structures Lab	-	2	1
SEC	SEC-154	Python Programming Lab	-	2	1
ES	ES-156/ ES-158	*Any one of the following corresponding to the theory paper offered: Basics of Electrical Engineering Lab/ Basics of Electronics Engineering Lab	-	2	1
BS	BS-160/ BS-162	*Any one of the following corresponding to the theory paper offered: Engineering Physics Lab/ Engineering Chemistry Lab	-	2	1
Total			21	8	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 school shall decide which paper to offer in which semester.

BRIDGE COURSE FOR LATERAL ENTRY STUDENTS

Provision for Lateral Entry of Students

Lateral entry of students shall be allowed as per University rules, regulations and policy. These students shall be admitted in the second year of the degree programme. Such students shall study the papers / courses offered from the second year onwards only. Only the credits earned for the papers of second to fourth year of the programme of study shall be considered for the award of the degree to the lateral entry students. In addition to these papers/course of second to fourth year of study, these students have to study two papers / courses, namely (first time offered in the 3rd semester):

Paper Code	Paper Name	L/P
BC-001	Bridge Course in Mathematics	4
BC-002	Bridge Course in Programming in C	4

Implementation Rules for Bridge Courses:

1. The Class incharges for the third semester of the batch (appointed by the Dean, USICT) shall act as the mentor of the lateral entry students for these courses.
2. These papers have to be qualified by the students. The students shall study the bridge course in self-study mode under the mentorship of the mentors.
3. For these papers examination shall be conducted by the concerned subject teacher / mentor 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 (passmarks are 40 out of 100) 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.
7. Students shall study the paper in the self study mode. A Mentor shall be allocated by the academic programme committee of the School to groups of lateral entry students. Mentors shall interact with the students to clarify, guide, assignments (given by the mentor) and evaluation of the course.

B.Tech/M.Tech Dual Degree

Third Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-201	Computer Organization and Architecture	4	-	4
PC	PC-203	Database Management Systems	3	-	3
PC	PC-205	Object Oriented Programming using Java	4	-	4
PC	PC-207	Design and Analysis of Algorithms	4	-	4
PC	PC-209	Operating Systems	3	-	3
AEC	AEC-211/ AEC-213	*Any one of the following: Principles of Management/ Engineering Economics	2	-	2
Practical/ Viva Voce					
PC	PC-251	Database Management Systems Lab	-	2	1
PC	PC-253	Object Oriented Programming using Java Lab	-	2	1
PC	PC-255	Design and Analysis of Algorithms Lab	-	2	1
PC	PC-257	Operating Systems Lab	-	2	1
PC	PC-259	Term Paper – I**			2
Total			20	8	26

*For a particular batch of a programme of study one out of these two papers shall be taught in the third semester while the other shall be taught in the 4th semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 3rd semester and similarly for the students who study the paper in the fourth semester. The school shall decide which paper to offer in which semester.

**NUES: The paper is an NUES paper. The concerned teacher to evaluate out of 100

B.Tech/M.Tech Dual Degree

Fourth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-202	Theory of Computation	4	-	4
PC	PC-204	Software Engineering	3	-	3
PC	PC-206	Computer Networks	4	-	4
PC	PC-208	Artificial Intelligence & Machine Learning	4	-	4
PC	PC-210	Web Technologies	3	-	3
AEC	AEC-212/ AEC-214	*Any one of the following: Engineering Economics/ Principles of Management	2	-	2
Practical/ Viva Voce					
PC	PC-252	Software Engineering Lab	-	2	1
PC	PC-254	Computer Networks Lab	-	2	1
PC	PC-256	Artificial Intelligence & Machine Learning Lab	-	2	1
PC	PC-258	Web Technologies Lab	-	2	1
PC	PC-260	Term Paper – II*			2
Total			22	8	26

*For a particular batch of a programme of study one out of these two papers shall be taught in the third semester while the other shall be taught in the 4th semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 3rd semester and similarly for the students who study the paper in the fourth semester. The school shall decide which paper to offer in which semester.

Note: The minor specializations are offered through the following routes:

- a. Program Electives (PE): Electives that may be chosen as per the list specified in this document. These papers may be a part of other elective groups offered to the students. If it is a part of the student's minor specialization elective group, then the students cannot take the paper in this part of the scheme of studies.
- b. Program Core Electives (PCE): Groups of 5 courses / papers are offered for specific minor specialization groups.
- c. Emerging Area Elective (EAE) or Open Area Elective Group (OAE): Groups of 5 courses / papers are offered for specific minor specialization groups. These specialization groups are offered by USICT as detailed in this document. Or, they may be offered by other schools of the University at the Dwarka campus of the University. These groups, if offered by other schools shall be called Open elective groups / minor specializations. The open elective groups must be offered as per the framework specified in this document.

B.Tech/M.Tech Dual Degree

Fifth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-303	Compiler Design	3	-	3
PC	PC-305	Programming in C++	3	-	3
PE		Elective – 1	-	-	4
PCE		#Elective PCE 1 (students to choose one group)	-	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school – 1 (students to choose 1 group)	-	-	4
VAC*	PC-301	Technical and Scientific Writing	2	-	2
Practical/ Viva Voce					
PC	PC-397	Summer Training (after 4 th semester) Report	-	-	2
PC	PC-399	Term Paper – III*	-	-	2
PC	PC-321	Compiler Design Lab		2	1
PC	PC-323	Programming in C++ Lab		2	1
Total			-	4	26

* NUES

#Students may choose from one group for a minor specialization (that is one group of papers for programme core elective (PCE) based minor specialization and the other for emerging area elective (EAE) based specializations or Open areas elective groups offered by the School or other schools (as per the pattern of group formation in this scheme). Such courses/papers (even in subsequent semesters), if they have a practical component, then the course shall be divided into two separate components. A theory component paper with a unique paper code with 3 credits and a practical component paper with another unique paper code with 1 credit. However, if there is no practical component, then the course / paper shall be a pure theory paper with 4 credits. Minor specialization is awarded only if all 20 credits are awarded / earned from the group of minor specialization chosen. The school shall offer the electives based on availability of resources in the school

B.Tech/M.Tech Dual Degree

Sixth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PE		Elective – 2	-	-	4
PE		Elective – 3	-	-	4
PCE		Elective PCE2	-	-	4
PCE		Elective PCE3	-	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school –2	-	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school –3	-	-	4
Practical/ Viva Voce					
VAC	VAC-398	** NSS/NCC/Cultural Clubs/Technical Society/ Technical Club/Institution's Innovation Council	-	-	2
Total			-		26

** NUES

Note: The route for the award of the degree has to be chosen by the student at the end of the 6th semester or the 3rd year. That is, the students shall be allowed to choose from one of the following three routes, for the award of the degree:

- Regular route:** The students taking this route shall continue with the study of the courses / papers in the 7th semester of 24 credits and a project or internship in the 8th semester. This route may lead to the award of two minor specializations.
- Internship route:** The students taking this route shall be required to undergo Internship at an organization. The organization shall offer an Internship to the student. The Internship offer shall be through the Training and Placement officer of the school, only. Students shall not be allowed to accept an Internship through any route. The students shall be required to submit an internship report in both the 7th and 8th semester. The reports shall contain the journal kept by the student summarizing weekly work done, countersigned by the mentor allocated by the Internship mentor at

the Organization. There shall an internal teacher also allocated to the student as a mentor for the Internship progress guidance and evaluation.

- c. **Research route:** The students taking this route be required to join research internship under mentorship of an academician at an organization. The topic of work of the student and the mentor (including the organization) shall be approved by the APC of the school. The student is required to publish at least one conference paper in a reputed conference / journal (meaning thereby, that its proceeding (if it is a conference) or the paper shall be indexed in Web of Science and/or Scopus) before the submission of the 8th semester dissertation. The research route is to be allowed only to students who have no “fail” paper till 6th semester, that is, all papers upto and including 6th semester have been passed by the student and after 6th semester the student has a CGPA of 7.5 or more.

B.Tech/M.Tech Dual Degree

Seventh Semester (Regular Route)					
Group	Code	Paper	L	P	Credits
Theory Papers					
PCE		Core area Elective PCE – 4 / MOOC ²	4	-	4
PCE		Core area Elective PCE – 5 / MOOC ²	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school – 4/ MOOC ²	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school – 5/ MOOC ²	4	-	4
Practical/ Viva Voce					
PC	PC 483	Minor Project ¹	-	-	8
PC	PC 481	Summer Training (after 6 th Semester) Report*	-	-	2
Total					26

* NUES

¹ Mandatory Paper, this paper must be passed by the student for award of the degree. The student shall be allocated a supervisor / guide for project work at the end of 6th semester by the School, 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 back-ground 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 the concerned supervisor while the term end examinations 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 Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school. However, the APC of the school may allow change of route from the "Regular Route" to "Internship Route" in the eighth semester, but students changing their route to "Internship Route", in the eight semester shall not be eligible for the award of the Honours degree.

² The student is allowed to do the elective through MOOCs (Massive Open Online Courses) offered through SWAYAM / NPTEL platform. For this purpose, the student must apply to the school for doing the elective course through MOOC. Only with the approval of the DEAN, USICT, the student may attend the course. All cost for attending and examinations have to be borne by the student. Such courses shall be of 4 or more credits (but shall be accounted for as 4 credits only). The marksheet of the MOOC shall have to be submitted to the school for onward transmission to the Examinations division of the University to include in the records of examinations and count the credits accrued (as 4 credits) together with the marks. These marks shall be reflected in the marksheet of the 7th semester. The student has to seek permission for the MOOC course / paper option by the end of the 6th semester. The marksheet issued by the MOOCs authority have to be submitted by the student within 12 weeks of completion of classes of the 7th semester. Failure to do so, shall imply the student is **absent** in the allowed paper through MOOCs.

Seventh Semester (Internship Route)#					
Group	Code	Paper	L	P	Credits
Internship	PC 485 ¹	Internship Report – I and Viva Voce #	-	-	10
	PC 489 ¹	Internship – I Progress Evaluation**	-	-	6
Practical/ Viva Voce					
PC	PC 483	Minor Project ¹	-	-	8
AEC	PC 481	* Summer Training (after 6 th Sem) Report	-	-	2
Total			-	-	26

¹ Mandatory Paper, this paper must be passed by the student for award of the degree. The student shall be allocated a supervisor / guide for project work at the end of 6th semester by the School, 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 back-ground 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 the concerned supervisor while the term end examinations 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 Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school.

Students are allowed to do internship in this semester, if following this route for the award of the degree. 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. An internal mentor shall also be assigned by the school. The student shall continue on this route for completion of the requirements of the degree in the final semester. However, the APC of the school may allow change of route to the "Regular Route" in the eighth semester, but students changing their route from "Internship Route" to "Regular Route", in the eight semester, shall not be eligible for award of minor specialization(s) and / or Honours.

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

** NUES: Evaluation by a committee of teachers, constituted by the Academic Programme Committee, out of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

Internship Viva Voce: Evaluation shall be conducted of 40 marks (Teachers' continuous evaluation / internal assessment) by the mentor (internal and/or external). And, 60 marks by a bench of the internal mentor and the external examiner deputed by examinations division(COE), for a total of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

Seventh Semester (Research Route)#					
Group	Code	Paper	L	P	Credits
Research	PC 491 ¹	Research Work Report – I and Viva Voce [#]	-	-	18
	PC 495 ¹	Research Work – I Progress Evaluation**	-	-	6
Practical/ Viva Voce					
AEC	PC 481	* Summer Training (after 6 th Sem) Report	-	-	2
Total			-	-	22

Students are allowed to do academic research in this semester, if following this route for the award of the degree. The students allowed to proceed for this route shall be required to submit a report (ICT491). The report has to be countersigned by the mentor concerned. Marks out of 40 have to awarded by the mentor (on a performa to be provided by the school) and submitted confidentially to the school (this may be done through email). The same has to be countersigned by the mentor at the organization where internship is completed. The format of the report shall be specified by the school. The student shall continue on this route for completion of the requirements of the degree in the final semester. However, the APC of the school may allow change of route to the "Regular Route" in the eighth semester, but students changing their route from "Research Route" to "Regular Route", in the eight semester, shall not be eligible for award of minor specialization(s) minor specialization(s) and / or Honours.

*NUES: Evaluation by the committee of teachers, constituted by the Academic Programme Committee, out of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

B.Tech/M.Tech Dual Degree

Eighth Semester					
Group	Code	Paper	L	P	Credits
Regular Route					
Project	PC 402 ¹	Major Project – Report and Viva Voce	-	-	20
	PC 406 ¹	Major Project Progress Evaluation*	-	-	6
Internship Route					
Internship	PC 408 ¹	Internship Report – II	-	-	8
	PC 412 ¹	Internship Progress Evaluation*	-	-	4
Project	PC 414 ¹	Major Project – Report			10
	PC 418 ¹	Major Project Progress Evaluation*			6
Research Route					
Research	PC 420 ¹	Thesis** and Viva Voce	-	-	20
	PC 424 ¹	Research Work Progress Evaluation*	-	-	6
Total			-	-	26

Note: The student continues with the degree route as completed in the seventh semester. However, the APC of the school may allow changes within the scope of this document.

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

** Submission of the thesis is to be allowed only if a paper has been accepted / published in a Scopus /Web of Science indexed conference / journal.

In the absence of the supervisor, the Dean of the School can assign the responsibility of the supervisor to any faculty of the school.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

PROGRAMME ELECTIVE PAPERS

Paper	Paper Code	Paper Name	T	P	Credits
Semester 5: Choose any one paper					
PE331	PE 331T	Digital Signal Processing	3	-	3
	PE 331P	Digital Signal Processing Lab	-	2	1
PE333	PE333T	Natural Language Processing	3	-	3
	PE333P	Natural Language Processing Lab	-	2	1
Semester 6: Choose any two papers (One paper from each Group)					
GROUP 1(Choose 1)					
PE332	PE 332T	Computational Optimization	3	-	3
	PE 332P	Computational Optimization Lab	-	2	1
PE334	PE 334T	Mobile Ad hoc Networks	3	-	3
	PE 334P	Mobile Ad hoc Networks Lab	-	2	1
PE336	PE 336T	Digital Image Processing	3	-	3
	PE 336P	Digital Image Processing Lab	-	2	1
PE338	PE 338T	Random Processes and Stochastic System	4	-	4
PE340	PE 340T	Network Security and Cryptography	3	-	3
	PE 340P	Network Security and Cryptography Lab	-	2	1
PE342	PE 342T	Fuzzy Sets and Fuzzy Logic	3	-	3
	PE 342P	Fuzzy Sets and Fuzzy Logic	-	2	1
PE344	PE 344T	Information Theory and Coding	4	-	4
PE346	PE 346T	Cloud Computing	4	-	4
PE348	PE 348T	Quantum Computing	4	-	4
GROUP 2(Choose 1)					
PE350	PE 350T	Semantic Web	3	-	3
	PE 350P	Semantic Web Lab	-	2	1
PE352	PE 352T	Software Project Management	3	-	3
	PE 352P	Software Project Management Lab	-	2	1
PE356	PE 356T	Data Warehousing and Business Intelligence	3	-	3
	PE 356P	Data Warehousing and Business Intelligence Lab	-	2	1
PE358	PE 358T	Unsupervised Learning	3	-	3
	PE 358P	Unsupervised Learning Lab	-	2	1
PE360	PE 360T	Advanced Java Programming	3	-	3
	PE 360P	Advanced Java Programming Lab.	-	2	1
PE362	PE 362T	Cyber Security and Forensics	4	-	4
PE364	PE 364T	Mobile Computing	3	-	3
	PE 364P	Mobile Computing Lab	-	2	1
PE366	PE 366T	E-Commerce	4	-	4
PE368	PE 368T	Introduction to IoT	3	-	3
	PE 368P	Introduction to IoT Lab	-	2	1

MINOR SPECIALIZATION STREAMS

(Programme Core Elective Streams)

These papers / streams shall be offered as per the prerequisite specified. The papers are to be offered to at the undergraduate level to the students of Undergraduate part of the Dual Degree programme. A course/ paper is identified by the code allocated. A course may be split in to a theory component which shall have the letter 'T' attached while its practical component shall have the letter 'P' suffixed. A student has to study both the theory and the practical component, of a course, if taken as an elective.

Programme Core Elective Group: Minor Specialization in Software Engineering and DevOps

Code	PaperCode	Paper	L	P	Credits	Semester
PCE349	PCE 349T	Advanced Software Architecture and System Design	3	-	3	5 th
	PCE 349P	Advanced Software Architecture and System Design Lab	-	2	1	
PCE374	PCE 374T	Software Testing, Verification and Validation	3	-	3	6 th
	PCE 374P	Software Testing, Verification and Validation Lab	-	2	1	
PCE376	PCE 376T	DevOps and Continuous Delivery	3	-	3	6 th
	PCE 376P	DevOps and Continuous Delivery Lab	-	2	1	
PCE401	PCE 401T	Secure Software Engineering	3	-	3	7 th
	PCE 401P	Secure Software Engineering Lab	-	2	1	
PCE405	PCE405T	Software Project Management and Engineering Economics	3	-	3	7 th
	PCE405P	Software Project Management and Engineering Economics Lab	-	2	1	

Note: The students opting for this group cannot take the papers PE352 Programme Electives

Programme Core Elective Group: Minor Specialization in Software Engineering

Code	PaperCode	Paper	L	P	Credits	Semester
PCE349	PCE 349T	Advanced Software Architecture and System Design	3	-	3	5 th
	PCE 349P	Advanced Software Architecture and System Design Lab	-	2	1	
PCE378	PCE 378T	Software Requirements and Estimation	3	-	3	6 th
	PCE 378P	Software Requirements and Estimation Lab	-	2	1	
PCE374	PCE 374T	Software Testing, Verification and Validation	3	-	3	6 th
	PCE 374P	Software Testing, Verification and Validation Lab	-	2	1	
PCE407	PCE 407T	Software Metrics and Predictive Modelling	3	-	3	7 th
	PCE 407P	Software Metrics and Predictive Modelling Lab	-	2	1	
PCE401	PCE 401T	Secure Software Engineering	3	-	3	7 th
	PCE 401P	Secure Software EngineeringLab	-	2	1	

Note: The students opting for this group cannot take the papers PE352 as Programme Electives

MINOR SPECIALIZATION STREAMS (EMERGING AREA ELECTIVE GROUPS)

Emerging Area Elective Group: Minor Specialization in Artificial Intelligence

Code	PaperCode	Paper	L	P	Credits	Semester
EAE355	EAE 355T	Statistics and Statistical Modelling	3	-	3	5 th
	EAE 355P	Statistics and Statistical Modelling Lab	-	2	1	
EAE388	EAE 388T	Advanced Machine Learning	3	-	3	6 th
	EAE 388P	Advanced Machine Learning Lab	-	2	1	
EAE390	EAE 390T	Introduction to Data Analytics and Data Visualisation	3	-	3	6 th
	EAE 390P	Introduction to Data Analytics and Data Visualisation Lab	-	2	1	
EAE415	EAE 415T	Large Language Models and Generative AI	3	-	3	7 th
	EAE 415P	Large Language Models and Generative AI Lab	-	2	1	
EAE417	EAE 417T	Deep Learning and Reinforcement Learning	3	-	3	7 th
	EAE 417P	Deep Learning and Reinforcement Learning Lab	-	2	1	

Note: The students opting for this group cannot take the papers PE335, PE337, PE341, PE358 as Programme Electives

Emerging Area Elective Group: Minor Specialization in Data Science

Code	PaperCode	Paper	L	P	Credits	Semester
EAE 355	EAE 355T	Statistics and Statistical Modelling	3	-	3	5 th
	EAE 355P	Statistics and Statistical Modelling Lab	-	2	1	
EAE 388	EAE 388T	Advanced Machine Learning	3	-	3	6 th
	EAE 388P	Advanced Machine Learning Lab	-	2	1	
EAE 390	EAE 390T	Introduction to Data Analytics and Data Visualisation	3	-	3	6 th
	EAE 390P	Introduction to Data Analytics and Data Visualisation Lab	-	2	1	
EAE 419	EAE 419T	Data Warehousing and Business Intelligence	3	-	3	7 th
	EAE 419P	Data Warehousing and Business Intelligence Lab	-	2	1	
EAE 413	EAE 413T	Big Data Analytics	3	-	3	7 th
	EAE 413P	Big Data Analytics Lab	-	2	1	

Note: The students opting for this group cannot take the papers PE335, PE337, PE341, PE356, PE358 as Programme Electives

MINOR SPECIALIZATION STREAMS (OPEN AREA ELECTIVE GROUPS)

Open Area Elective Group: Minor Specialization in Internet of Things

Code	PaperCode	Paper	L	P	Credits	Semester
OAE 361	OAE 361T	Introduction to IoT	3	-	3	5th
	OAE 361P	Introduction to IoT Lab	-	2	1	
OAE 304	OAE 304T	Embedded Systems	3	-	3	6th
	OAE 304P	Embedded Systems Lab	-	2	1	
OAE 306	OAE 306T	Wireless Sensor Networks	3	-	3	6th
	OAE 306P	Wireless Sensor Networks Lab	-	2	1	
OAE 429	OAE 429T	Edge and Fog Computing	3	-	3	7th
	OAE 429P	Edge and Fog Computing Lab	-	2	1	
OAE 431	OAE 431T	Industrial IoT	3	-	3	7th
	OAE 431P	Industrial IoT Lab	-	2	1	

Note: The students opting for this group cannot take the papers PE368 as Programme Electives

Scheme
Bachelor of Technology / Master of Technology
(Dual Degree Programmes)
In
Computer Science and Engineering – Artificial Intelligence
(Major Discipline)

B.Tech/M.Tech Dual Degree

First Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
ES	ES-101	Programming for Problem Solving	4	-	4
ES	ES-103/ ES-105	*Any one of the following: Basics of Electrical Engineering/ Basics of Electronics Engineering	3	-	3
BS	BS-107	Engineering Mathematics – I	4	-	4
BS	BS-109/ BS-111	*Any one of the following: Engineering Chemistry/ Engineering Physics	3	-	3
ES/ AEC	ES-113/ AEC-115	*Any one of the following: Engineering Mechanics/ Communication Skills	3	-	3
VAC	VAC-117	*Indian Constitution	2	-	2
VAC	VAC-119	**Human Values & Ethics	2	-	2
Practical/ Viva Voce					
ES	ES-151	Programming for Problem Solving Lab	-	2	1
ES	ES-153/ ES-155	*Any one of the following corresponding to the theory paper offered: Basics of Electrical Engineering Lab/ Basics of Electronics Engineering Lab	-	2	1
BS	BS-157/ BS-159	*Any one of the following corresponding to the theory paper offered: Engineering Chemistry Lab/Engineering Physics Lab	-	2	1
Total			21	6	24

Group	Code	Paper	L	P	Credits
VAC		**NSS/NCC/Cultural Clubs/Technical Society/ Technical Club/Institution's Innovation Council	-	-	2
VAC	VAC-161	***Environment Studies	-	-	0

Note: Orientation/ Student Induction program will be offered to the students, right at the start of the first semester.

* 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 school shall decide which paper to offer in which semester.

*This is an NUES paper.

**This is an NUES paper. Every student is required to complete this paper of at least 2 credits through SWAYAM / NPTEL MOOCs platform, with the approval of the Dean, USIC&T. If the student completes a course with the higher number of credits from SWAYAM / NPTEL MOOCs platform, the credits reflected in the university marksheet shall be only 2 credits. The marksheet of successfully completing the paper/course with at least 40% marks has to be submitted to the school by the end of the 6th semester (3rd year) of studies. The cost of the paper/course including its examination fee is to be borne by the student. The clearance of the paper/course is mandatory for the award of the degree. The result of this subject shall be incorporated in the 6th semester marksheet.

****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.

*****Non-credit:** Every student is required to complete an Environmental Studies paper of at least 2 credits through SWAYAM / NPTEL MOOCs platform with the approval of Dean, USIC&T. This shall be considered as a non-credit paper/course. The marksheet of successfully completing the paper/course with at least 40% marks has to be submitted to the school by the end of the 6th semester (3rd year) of studies. The cost of the paper/course including its examination fee is to be borne by the student. The clearance of the paper/course is mandatory for the award of the degree.

B.Tech/M.Tech Dual Degree

Second Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
ES	ES-102	Data Structures	4	-	4
SEC	SEC-104	Python Programming	4	-	4
ES	ES-106/ ES-108	*Any one of the following: Basics of Electrical Engineering/ Basics of Electronics Engineering	3	-	3
BS	BS-110	Engineering Mathematics – II	4	-	4
BS	BS-112/ BS-114	*Any one of the following: Engineering Physics/ Engineering Chemistry	3	-	3
ES/ AEC	ES-116/ AEC-118	*Any one of the following: Engineering Mechanics/ Communication Skills	3	-	3
Practical/ Viva Voce					
ES	ES-152	Data Structures Lab	-	2	1
SEC	SEC-154	Python Programming Lab	-	2	1
ES	ES-156/ ES-158	*Any one of the following corresponding to the theory paper offered: Basics of Electrical Engineering Lab/ Basics of Electronics Engineering Lab	-	2	1
BS	BS-160/ BS-162	*Any one of the following corresponding to the theory paper offered: Engineering Physics Lab/ Engineering Chemistry Lab	-	2	1
Total			21	8	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 school shall decide which paper to offer in which semester.

BRIDGE COURSE FOR LATERAL ENTRY STUDENTS

Provision for Lateral Entry of Students

Lateral entry of students shall be allowed as per University rules, regulations and policy. These students shall be admitted in the second year of the degree programme. Such students shall study the papers / courses offered from the second year onwards only. Only the credits earned for the papers of second to fourth year of the programme of study shall be considered for the award of the degree to the lateral entry students. In addition to these papers/course of second to fourth year of study, these students have to study two papers / courses, namely (first time offered in the 3rd semester):

Paper Code	Paper Name	L/P
BC-001	Bridge Course in Mathematics	4
BC-002	Bridge Course in Programming in C	4

Implementation Rules for Bridge Courses:

1. The Class incharges for the third semester of the batch (appointed by the Dean, USICT) shall act as the mentor of the lateral entry students for these courses.
2. These papers have to be qualified by the students. The students shall study the bridge course in self-study mode under the mentorship of the mentors.
3. For these papers examination shall be conducted by the concerned subject teacher / mentor 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.
7. Students shall study the paper in the self study mode. A Mentor shall be allocated by the academic programme committee of the School to groups of lateral entry students. Mentors shall interact with the students to clarify, guide, assignments (given by the mentor) and evaluation of the course.

B.Tech/M.Tech Dual Degree

Third Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-201	Computer Organization and Architecture	4	-	4
PC	PC-203	Database Management Systems	3	-	3
PC	PC-205	Object Oriented Programming using Java	4	-	4
PC	PC-207	Design and Analysis of Algorithms	4	-	4
PC	PC-209	Operating Systems	3	-	3
AEC	AEC-211/ AEC-213	*Any one of the following: Principles of Management/ Engineering Economics	2	-	2
Practical/ Viva Voce					
PC	PC-251	Database Management Systems Lab	-	2	1
PC	PC-253	Object Oriented Programming using Java Lab	-	2	1
PC	PC-255	Design and Analysis of Algorithms Lab	-	2	1
PC	PC-257	Operating Systems Lab	-	2	1
PC	PC-259	Term Paper – I**			2
Total			20	8	26

*For a particular batch of a programme of study one out of these two papers shall be taught in the third semester while the other shall be taught in the 4th semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 3rd semester and similarly for the students who study the paper in the fourth semester. The school shall decide which paper to offer in which semester.

**NUES: The paper is an NUES paper. The concerned teacher to evaluate out of 100

B.Tech/M.Tech Dual Degree

Fourth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-202	Theory of Computation	4	-	4
PC	PC-204	Software Engineering	3	-	3
PC	PC-206	Computer Networks	4	-	4
PC	PC-208	Artificial Intelligence & Machine Learning	4	-	4
PC	PC-210	Web Technologies	3	-	3
AEC	AEC-212/ AEC-214	*Any one of the following: Engineering Economics/ Principles of Management	2	-	2
Practical/ Viva Voce					
PC	PC-252	Software Engineering Lab	-	2	1
PC	PC-254	Computer Networks Lab	-	2	1
PC	PC-256	Artificial Intelligence & Machine Learning Lab	-	2	1
PC	PC-258	Web Technologies Lab	-	2	1
PC	PC-260	Term Paper – II*			2
Total			22	8	26

*For a particular batch of a programme of study one out of these two papers shall be taught in the third semester while the other shall be taught in the 4th semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 3rd semester and similarly for the students who study the paper in the fourth semester. The school shall decide which paper to offer in which semester.

Note: The minor specializations are offered through the following routes:

- d. Program Electives (PE): Electives that may be chosen as per the list specified in this document. These papers may be a part of other elective groups offered to the students. If it is a part of the student's minor specialization elective group, then the students cannot take the paper in this part of the scheme of studies.
- e. Program Core Electives (PCE): Groups of 5 courses / papers are offered for specific minor specialization groups.
- f. Emerging Area Elective (EAE) or Open Area Elective Group (OAE): Groups of 5 courses / papers are offered for specific minor specialization groups. These specialization groups are offered by USICT as detailed in this document. Or, they may be offered by other schools of the University at the Dwarka campus of the University. These groups, if offered by other schools shall be called Open elective groups / minor specializations. The open elective groups must be offered as per the framework specified in this document.

B.Tech/M.Tech Dual Degree

Fifth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC303	Compiler Design	3	-	3
PC	PC 305	Programming in C++	3	-	3
PE		Elective – 1	4	-	4
PC	PC 307	Statistics and Statistical Modelling	3	-	3
PC	PC 309	Advanced Machine Learning	3	-	3
VAC*	PC 301	Technical and Scientific Writing	2	-	2
Practical/ Viva Voce					
PC	PC-397	Summer Training (after 4 th semester) Report	-	-	2
PC	PC-399	Term Paper – III*	-	-	2
PC	PC-321	Compiler Design Lab		2	1
PC	PC-323	Programming in C++ Lab		2	1
PC	PC 395P	Statistics and Statistical Modelling Lab	-	2	1
PC	PC 393P	Advanced Machine Learning Lab	-	2	1
Total			20	4	26

* NUES

#Students may choose from one group for a minor specialization (that is one group of papers for programme core elective (PCE) based minor specialization and the other for emerging area elective (EAE) based specializations or Open areas elective groups offered by the School or other schools (as per the pattern of group formation in this scheme). Such courses/papers (even in subsequent semesters), if they have a practical component, then the course shall be divided into two separate components. A theory component paper with a unique paper code with 3 credits and a practical component paper with another unique paper code with 1 credit. However, if there is no practical component, then the course / paper shall be a pure theory paper with 4 credits. Minor specialization is awarded only if all 20 credits are awarded / earned from the group of minor specialization chosen. The school shall offer the electives based on availability of resources in the school

B.Tech/M.Tech Dual Degree

Sixth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PE		Elective – 2	4	-	4
PE		Elective – 3	4	-	4
PC	PC 302	Introduction to Data Analytics and Data Visualisation	3	-	3
PC	PC 304	Optimization Techniques for Machine Learning	3	-	3
PC	PC 306	Deep Learning and Reinforcement Learning	3	-	3
PC	PC 308	Big Data Analytics and Distributed ML	3	-	3
Practical/ Viva Voce					
VAC	VAC-398	** NSS/NCC/Cultural Clubs/Technical Society/ Technical Club/Institution's Innovation Council	-	-	2
PC	PC 396	Introduction to Data Analytics and Data Visualisation Lab	-	2	1
PC	PC 394	Optimization Techniques for Machine Learning Lab	-	2	1
PC	PC 392	Deep Learning and Reinforcement Learning	-	2	1
PC	PC 390	Big Data Analytics and Distributed ML Lab	-	2	1
Total			24		26

** NUES

Note: The route for the award of the degree has to be chosen by the student at the end of the 6th semester or the 3rd year.

That is, the students shall be allowed to choose from one of the following three routes, for the award of the degree:

- d. **Regular route:** The students taking this route shall continue with the study of the courses / papers in the 7th semester of 24 credits and a project or internship in the 8th semester. This route may lead to the award of two minor specializations.
- e. **Internship route:** The students taking this route shall be required to undergo Internship at an organization. The organization shall offer an Internship to the student. The Internship offer shall be through the Training and Placement

officer of the school, only. Students shall not be allowed to accept an Internship through any route. The students shall be required to submit an internship report in both the 7th and 8th semester. The reports shall contain the journal kept by the student summarizing weekly work done, countersigned by the mentor allocated by the Internship mentor at the Organization. There shall an internal teacher also allocated to the student as a mentor for the Internship progress guidance and evaluation.

- f. **Research route:** The students taking this route be required to join research internship under mentorship of an academician at an organization. The topic of work of the student and the mentor (including the organization) shall be approved by the APC of the school. The student is required to publish at least one conference paper in a reputed conference / journal (meaning thereby, that its proceeding (if it is a conference) or the paper shall be indexed in Web of Science and/or Scopus) before the submission of the 8th semester dissertation. The research route is to be allowed only to students who have no “fail” paper till 6th semester, that is, all papers upto and including 6th semester have been passed by the student and after 6th semester the student has a CGPA of 7.5 or more.

B.Tech/M.Tech Dual Degree

Seventh Semester (Regular Route)					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC 402T ²	Probabilistic Graphical Models and Bayesian Learning	3	-	3
PC	PC 404T ²	Time Series Analysis and Forecasting	3	-	3
PC	PC 406T ²	Large Language Models and Generative AI	3	-	3
PC	PC 408T ²	MLOps and AI Systems Engineering	3	-	3
Practical/ Viva Voce					
PC	PC 483	Minor Project ¹	-	-	8
PC	PC 481	Summer Training (after 6 th Semester) Report*	-	-	2
PC	PC 402P ²	Probabilistic Graphical Models and Bayesian Learning Lab	-	2	1
PC	PC 404P ²	Time Series Analysis and Forecasting Lab	-	2	1
PC	PC 406P ²	Optimization Techniques for Machine Learning Lab	-	2	1
PC	PC 408P ²	MLOps and AI Systems Engineering Lab	-	2	1
Total					26

* NUES

¹ Mandatory Paper, this paper must be passed by the student for award of the degree. The student shall be allocated a supervisor / guide for project work at the end of 6th semester by the School, 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 back-ground 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 the concerned supervisor while the term end examinations 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 Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school. However, the APC of the school may allow change of route from the "Regular Route" to "Internship Route" in the eighth semester, but students changing their route to "Internship Route", in the eight semester shall not be eligible for the award of the Honours degree.

² The student is allowed to do the paper through MOOCs (Massive Open Online Courses) offered through SWAYAM / NPTEL platform. For this purpose, the student must apply to the school for doing the paper/ course through MOOC. Only with the approval of the DEAN, USICT, the student may attend the course. All cost for attending and examinations have to be borne by the student. Such courses shall be of 4 or more credits (but shall be accounted for as 4 credits only). If the paper is allowed through as an equivalent paper then the practical part also shall be accounted for in the MOOC and no practical component shall be required. The marksheet of the MOOC shall have to be submitted to the school for onward transmission to the Examinations division of the University to include in the records of examinations and count the credits accrued (as 4 credits) together with the marks. These marks shall be reflected in the marksheet of the 7th semester. The student has to seek permission for the MOOC course / paper option by the end of the 6th semester. The marksheet issued by the MOOCs authority have to be submitted by the student within 12 weeks of completion of classes of the 7th semester. Failure to do so, shall imply the student is **absent** in the allowed paper through MOOCs. The student must specify which theory + practical paper the student wishes to replace through MOOC paper, and only in lieu of that combination, the students request shall be considered. The MOOC paper must be of at least 4 credits.

Seventh Semester (Internship Route)#					
Group	Code	Paper	L	P	Credits
Internship	PC 485 ¹	Internship Report – I and Viva Voce #	-	-	10
	PC 489 ¹	Internship – I Progress Evaluation**	-	-	6
Practical/ Viva Voce					
PC	PC 483	Minor Project ¹	-	-	8
AEC	PC 481	* Summer Training (after 6 th Sem) Report	-	-	2
Total			-	-	26

¹ Mandatory Paper, this paper must be passed by the student for award of the degree. The student shall be allocated a supervisor / guide for project work at the end of 6th semester by the School, 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 back-ground 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 the concerned supervisor while the term end examinations 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 Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school.

Students are allowed to do internship in this semester, if following this route for the award of the degree. 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. An internal mentor shall also be assigned by the school. The student shall continue on this route for completion of the requirements of the degree in the final semester. However, the APC of the school may allow change of route to the "Regular Route" in the eighth semester, but students changing their route from "Internship Route" to "Regular Route", in the eight semester, shall not be eligible for award of minor specialization(s) and / or Honours.

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

** NUES: Evaluation by a committee of teachers, constituted by the Academic Programme Committee, out of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

Internship Viva Voce: Evaluation shall be conducted of 40 marks (Teachers' continuous evaluation / internal assessment) by the mentor (internal and/or external). And, 60 marks by a bench of the internal mentor and the external examiner deputed by examinations division (COE), for a total of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

Seventh Semester (Research Route)#					
Group	Code	Paper	L	P	Credits
Research	PC 491 ¹	Research Work Report – I and Viva Voce [#]	-	-	18
	PC 495 ¹	Research Work – I Progress Evaluation**	-	-	6
Practical/ Viva Voce					
AEC	PC 481	* Summer Training (after 6 th Sem) Report	-	-	2
Total			-	-	22

Students are allowed to do academic research in this semester, if following this route for the award of the degree. The students allowed to proceed for this route shall be required to submit a report (ICT461). The report has to be countersigned by the mentor concerned. Marks out of 40 have to be awarded by the mentor (on a performa to be provided by the school) and submitted confidentially to the school (this may be done through email). The same has to be countersigned by the mentor at the organization where internship is completed. The format of the report shall be specified by the school. The student shall continue on this route for completion of the requirements of the degree in the final semester. However, the APC of the school may allow change of route to the "Regular Route" in the eighth semester, but students changing their route from "Research Route" to "Regular Route", in the eight semester, shall not be eligible for award of minor specialization(s) minor specialization(s) and / or Honours.

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

*NUES: Evaluation by the committee of teachers, constituted by the Academic Programme Committee, out of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

B.Tech/M.Tech Dual Degree

Eighth Semester					
Group	Code	Paper	L	P	Credits
Regular Route					
Project	PC 402 ¹	Major Project – Report and Viva Voce	-	-	20
	PC 406 ¹	Major Project Progress Evaluation*	-	-	6
Internship Route					
Internship	PC 408 ¹	Internship Report – II	-	-	8
	PC 412 ¹	Internship Progress Evaluation*	-	-	4
Project	PC 414 ¹	Major Project – Report			10
	PC 418 ¹	Major Project Progress Evaluation*			6
Research Route					
Research	PC 420 ¹	Thesis** and Viva Voce	-	-	20
	PC 424 ¹	Research Work Progress Evaluation*	-	-	6
Total			-	-	26

Note: The student continues with the degree route as completed in the seventh semester. However, the APC of the school may allow changes within the scope of this document.

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

** Submission of the thesis is to be allowed only if a paper has been accepted / published in a Scopus /Web of Science indexed conference / journal.

In the absence of the supervisor, the Dean of the School can assign the responsibility of the supervisor to any faculty of the school.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

PROGRAMME ELECTIVE PAPERS

Paper	Paper Code	Paper Name	T	P	Credits
Semester 5: Choose any one paper					
PE331	PE 331T	Digital Signal Processing	3	-	3
	PE 331P	Digital Signal Processing Lab	-	2	1
PE333	PE 333T	Natural Language Processing	3	-	3
	PE 333P	Natural Language Processing Lab	-	2	1
Semester 6: Choose any two papers (One paper from each Group)					
GROUP 1(Choose 1)					
PE332	PE 332T	Computational Optimization	3	-	3
	PE 332P	Computational Optimization Lab	-	2	1
PE334	PE 334T	Mobile Ad hoc Networks	3	-	3
	PE 334P	Mobile Ad hoc Networks Lab	-	2	1
PE336	PE 336T	Digital Image Processing	3	-	3
	PE 336P	Digital Image Processing Lab	-	2	1
PE338	PE 338T	Random Processes and Stochastic System	4	-	4
PE340	PE 340T	Network Security and Cryptography	3	-	3
	PE 340P	Network Security and Cryptography Lab	-	2	1
PE342	PE 342T	Fuzzy Sets and Fuzzy Logic	3	-	3
	PE 342P	Fuzzy Sets and Fuzzy Logic	-	2	1
PE344	PE 344T	Information Theory and Coding	4	-	4
PE346	PE 346T	Cloud Computing	4	-	4
PE348	PE 348T	Quantum Computing	4	-	4
GROUP 2(Choose 1)					
PE350	PE 350T	Semantic Web	3	-	3
	PE 350P	Semantic Web Lab	-	2	1
PE352	PE 352T	Software Project Management	3	-	3
	PE 352P	Software Project Management Lab	-	2	1
PE360	PE 360T	Advanced Java Programming	3	-	3
	PE 360P	Advanced Java Programming Lab.	-	2	1
PE362	PE 362T	Cyber Security and Forensics	4	-	4
PE364	PE 364T	Mobile Computing	3	-	3
	PE 364P	Mobile Computing Lab	-	2	1
PE366	PE 366T	E-Commerce	4	-	4
PE368	PE 368T	Introduction to IoT	3	-	3
	PE 368P	Introduction to IoT Lab	-	2	1

Scheme
Bachelor of Technology / Master of Technology
(Dual Degree Programmes)
In
Computer Science and Engineering – Data Science
(Major Discipline)

B.Tech/M.Tech Dual Degree

First Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
ES	ES-101	Programming for Problem Solving	4	-	4
ES	ES-103/ ES-105	*Any one of the following: Basics of Electrical Engineering/ Basics of Electronics Engineering	3	-	3
BS	BS-107	Engineering Mathematics – I	4	-	4
BS	BS-109/ BS-111	*Any one of the following: Engineering Chemistry/ Engineering Physics	3	-	3
ES/ AEC	ES-113/ AEC-115	*Any one of the following: Engineering Mechanics/ Communication Skills	3	-	3
VAC	VAC-117	*Indian Constitution	2	-	2
VAC	VAC-119	**Human Values & Ethics	2	-	2
Practical/ Viva Voce					
ES	ES-151	Programming for Problem Solving Lab	-	2	1
ES	ES-153/ ES-155	*Any one of the following corresponding to the theory paper offered: Basics of Electrical Engineering Lab/ Basics of Electronics Engineering Lab	-	2	1
BS	BS-157/ BS-159	*Any one of the following corresponding to the theory paper offered: Engineering Chemistry Lab/Engineering Physics Lab	-	2	1
Total			21	6	24

Group	Code	Paper	L	P	Credits
VAC		**NSS/NCC/Cultural Clubs/Technical Society/ Technical Club/Institution's Innovation Council	-	-	2
VAC	VAC-161	***Environment Studies	-	-	0

Note: Orientation/ Student Induction program will be offered to the students, right at the start of the first semester.

* 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 school shall decide which paper to offer in which semester.

*This is an NUES paper.

**This is an NUES paper. Every student is required to complete this paper of at least 2 credits through SWAYAM / NPTEL MOOCs platform, with the approval of the Dean, USIC&T. If the student completes a course with the higher number of credits from SWAYAM / NPTEL MOOCs platform, the credits reflected in the university marksheet shall be only 2 credits. The marksheet of successfully completing the paper/course with at least 40% marks has to be submitted to the school by the end of the 6th semester (3rd year) of studies. The cost of the paper/course including its examination fee is to be borne by the student. The clearance of the paper/course is mandatory for the award of the degree. The result of this subject shall be incorporated in the 6th semester marksheet.

****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.

*****Non-credit:** Every student is required to complete an Environmental Studies paper of at least 2 credits through SWAYAM / NPTEL MOOCs platform with the approval of Dean, USIC&T. This shall be considered as a non-credit paper/course. The marksheet of successfully completing the paper/course with at least 40% marks has to be submitted to the school by the end of the 6th semester (3rd year) of studies. The cost of the paper/course including its examination fee is to be borne by the student. The clearance of the paper/course is mandatory for the award of the degree.

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Second Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
ES	ES-102	Data Structures	4	-	4
SEC	SEC-104	Python Programming	4	-	4
ES	ES-106/ ES-108	*Any one of the following: Basics of Electrical Engineering/ Basics of Electronics Engineering	3	-	3
BS	BS-110	Engineering Mathematics – II	4	-	4
BS	BS-112/ BS-114	*Any one of the following: Engineering Physics/ Engineering Chemistry	3	-	3
ES/ AEC	ES-116/ AEC-118	*Any one of the following: Engineering Mechanics/ Communication Skills	3	-	3
Practical/ Viva Voce					
ES	ES-152	Data Structures Lab	-	2	1
SEC	SEC-154	Python Programming Lab	-	2	1
ES	ES-156/ ES-158	*Any one of the following corresponding to the theory paper offered: Basics of Electrical Engineering Lab/ Basics of Electronics Engineering Lab	-	2	1
BS	BS-160/ BS-162	*Any one of the following corresponding to the theory paper offered: Engineering Physics Lab/ Engineering Chemistry Lab	-	2	1
Total			21	8	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 school shall decide which paper to offer in which semester.

BRIDGE COURSE FOR LATERAL ENTRY STUDENTS

Provision for Lateral Entry of Students

Lateral entry of students shall be allowed as per University rules, regulations and policy. These students shall be admitted in the second year of the degree programme. Such students shall study the papers / courses offered from the second year onwards only. Only the credits earned for the papers of second to fourth year of the programme of study shall be considered for the award of the degree to the lateral entry students. In addition to these papers/course of second to fourth year of study, these students have to study two papers / courses, namely (first time offered in the 3rd semester):

Paper Code	Paper Name	L/P
BC-001	Bridge Course in Mathematics	4
BC-002	Bridge Course in Programming in C	4

Implementation Rules for Bridge Courses:

1. The Class incharges for the third semester of the batch (appointed by the Dean, USICT) shall act as the mentor of the lateral entry students for these courses.
2. These papers have to be qualified by the students. The students shall study the bridge course in self-study mode under the mentorship of the mentors.
3. For these papers examination shall be conducted by the concerned subject teacher / mentor 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 marksheets will be issued by the Examination Division of the University for the Bridge Course.
7. Students shall study the paper in the self study mode. A Mentor shall be allocated by the academic programme committee of the School to groups of lateral entry students. Mentors shall interact with the students to clarify, guide, assignments (given by the mentor) and evaluation of the course.

B.Tech/M.Tech Dual Degree

Third Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-201	Computer Organization and Architecture	4	-	4
PC	PC-203	Database Management Systems	3	-	3
PC	PC-205	Object Oriented Programming using Java	4	-	4
PC	PC-207	Design and Analysis of Algorithms	4	-	4
PC	PC-209	Operating Systems	3	-	3
AEC	AEC-211/ AEC-213	*Any one of the following: Principles of Management/ Engineering Economics	2	-	2
Practical/ Viva Voce					
PC	PC-251	Database Management Systems Lab	-	2	1
PC	PC-253	Object Oriented Programming using Java Lab	-	2	1
PC	PC-255	Design and Analysis of Algorithms Lab	-	2	1
PC	PC-257	Operating Systems Lab	-	2	1
PC	PC-259	Term Paper – I**			2
Total			20	8	26

*For a particular batch of a programme of study one out of these two papers shall be taught in the third semester while the other shall be taught in the 4th semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 3rd semester and similarly for the students who study the paper in the fourth semester. The school shall decide which paper to offer in which semester.

**NUES: The paper is an NUES paper. The concerned teacher to evaluate out of 100

B.Tech/M.Tech Dual Degree

Fourth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-202	Theory of Computation	4	-	4
PC	PC-204	Software Engineering	3	-	3
PC	PC-206	Computer Networks	4	-	4
PC	PC-208	Artificial Intelligence & Machine Learning	4	-	4
PC	PC-210	Web Technologies	3	-	3
AEC	AEC-212/ AEC-214	*Any one of the following: Engineering Economics/ Principles of Management	2	-	2
Practical/ Viva Voce					
PC	PC-252	Software Engineering Lab	-	2	1
PC	PC-254	Computer Networks Lab	-	2	1
PC	PC-256	Artificial Intelligence & Machine Learning Lab	-	2	1
PC	PC-258	Web Technologies Lab	-	2	1
PC	PC-260	Term Paper – II*			2
Total			22	8	26

*For a particular batch of a programme of study one out of these two papers shall be taught in the third semester while the other shall be taught in the 4th semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 3rd semester and similarly for the students who study the paper in the fourth semester. The school shall decide which paper to offer in which semester.

Note: The minor specializations are offered through the following routes:

- g. Program Electives (PE): Electives that may be chosen as per the list specified in this document. These papers may be a part of other elective groups offered to the students. If it is a part of the student's minor specialization elective group, then the students cannot take the paper in this part of the scheme of studies.
- h. Program Core Electives (PCE): Groups of 5 courses / papers are offered for specific minor specialization groups.
- i. Emerging Area Elective (EAE) or Open Area Elective Group (OAE): Groups of 5 courses / papers are offered for specific minor specialization groups. These specialization groups are offered by USICT as detailed in this document. Or, they may be offered by other schools of the University at the Dwarka campus of the University. These groups, if offered by other schools shall be called Open elective groups / minor specializations. The open elective groups must be offered as per the framework specified in this document.

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Fifth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC 303	Compiler Design	3	-	3
PC	PC 305	Programming in C++	3	-	3
PE		Elective – 1	4	-	4
PC	PC 307	Statistics and Statistical Modelling	3	-	3
PC	PC 309	Advanced Machine Learning	3	-	3
VAC*	PC 301	Technical and Scientific Writing	2	-	2
Practical/ Viva Voce					
PC	PC-397	Summer Training (after 4 th semester) Report	-	-	2
PC	PC-399	Term Paper – III*	-	-	2
PC	PC-321	Compiler Design Lab		2	1
PC	PC-323	Programming in C++ Lab		2	1
PC	PC 395P	Statistics and Statistical Modelling Lab	-	2	1
PC	PC 393P	Advanced Machine Learning Lab	-	2	1
Total			20	4	26

* NUES

#Students may choose from one group for a minor specialization (that is one group of papers for programme core elective (PCE) based minor specialization and the other for emerging area elective (EAE) based specializations or Open areas elective groups offered by the School or other schools (as per the pattern of group formation in this scheme). Such courses/papers (even in subsequent semesters), if they have a practical component, then the course shall be divided into two separate components. A theory component paper with a unique paper code with 3 credits and a practical component paper with another unique paper code with 1 credit. However, if there is no practical component, then the course / paper shall be a pure theory paper with 4 credits. Minor specialization is awarded only if all 20 credits are awarded / earned from the group of minor specialization chosen. The school shall offer the electives based on availability of resources in the school

B.Tech/M.Tech Dual Degree

Sixth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PE		Elective – 2	4	-	4
PE		Elective – 3	4	-	4
PC	PC 310	Introduction to Data Analytics and Data Visualisation	3	-	3
PC	PC 312	Data Warehousing and Business Intelligence	3	-	3
PC	PC 314	Big Data Analytics	3	-	3
PC	PC 316	Time Series Analysis and Forecasting	3	-	3
Practical/ Viva Voce					
VAC	VAC-398	** NSS/NCC/Cultural Clubs/Technical Society/ Technical Club/Institution's Innovation Council	-	-	2
PC	PC 396	Introduction to Data Analytics and Data Visualisation	-	2	1
PC	PC 386	Data Warehousing and Business Intelligence Lab	-	2	1
PC	PC 388	Big Data Analytics Lab	-	2	1
PC	PC 386	Time Series Analysis and Forecasting Lab	-	2	1
Total			24		26

** NUES

Note: The route for the award of the degree has to be chosen by the student at the end of the 6th semester or the 3rd year.
That is, the students shall be allowed to choose from one of the following three routes, for the award of the degree:

- g. **Regular route:** The students taking this route shall continue with the study of the courses / papers in the 7th semester of 24 credits and a project or internship in the 8th semester. This route may lead to the award of two minor specializations.

- h. **Internship route:** The students taking this route shall be required to undergo Internship at an organization. The organization shall offer an Internship to the student. The Internship offer shall be through the Training and Placement officer of the school, only. Students shall not be allowed to accept an Internship through any route. The students shall be required to submit an internship report in both the 7th and 8th semester. The reports shall contain the journal kept by the student summarizing weekly work done, countersigned by the mentor allocated by the Internship mentor at the Organization. There shall an internal teacher also allocated to the student as a mentor for the Internship progress guidance and evaluation.
- i. **Research route:** The students taking this route be required to join research internship under mentorship of an academician at an organization. The topic of work of the student and the mentor (including the organization) shall be approved by the APC of the school. The student is required to publish at least one conference paper in a reputed conference / journal (meaning thereby, that its proceeding (if it is a conference) or the paper shall be indexed in Web of Science and/or Scopus) before the submission of the 8th semester dissertation. The research route is to be allowed only to students who have no “fail” paper till 6th semester, that is, all papers upto and including 6th semester have been passed by the student and after 6th semester the student has a CGPA of 7.5 or more.

B.Tech/M.Tech Dual Degree

Seventh Semester (Regular Route)					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC 402T ²	Probabilistic Graphical Models and Bayesian Learning	3	-	3
PC	PC 410T ²	MLOps and Data Science Systems	3	-	4
PC	PC 412T ²	Optimization Techniques for Data Science	3	-	4
PC	PC 414T ²	Applied Data Science and Decision Systems	3	-	4
Practical/ Viva Voce					
PC	PC 483	Minor Project ¹	-	-	8
PC	PC 481	Summer Training (after 6 th Semester) Report*	-	-	2
PC	PC 402P ²	Probabilistic Graphical Models and Bayesian Learning Lab	-	2	1
PC	PC 410P ²	Time Series Analysis and Forecasting Lab	-	2	1
PC	PC 412P ²	Optimization Techniques for Machine Learning Lab	-	2	1
PC	PC 414P ²	MLOps and AI Systems Engineering Lab	-	2	1
Total					26

* NUES

¹ Mandatory Paper, this paper must be passed by the student for award of the degree. The student shall be allocated a supervisor / guide for project work at the end of 6th semester by the School, 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 back-ground 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 the concerned supervisor while the term end examinations 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 Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school. However, the APC of the school may allow change of route from the "Regular Route" to "Internship Route" in the eighth semester, but students changing their route to "Internship Route", in the eight semester shall not be eligible for the award of the Honours degree.

² The student is allowed to do the paper through MOOCs (Massive Open Online Courses) offered through SWAYAM / NPTEL platform. For this purpose, the student must apply to the school for doing the paper/ course through MOOC. Only with the approval of the DEAN, USICT, the student may attend the course. All cost for attending and examinations have to be borne by the student. Such courses shall be of 4 or more credits (but shall be accounted for as 4 credits only). If the paper is allowed through as an equivalent paper then the practical part also shall be accounted for in the MOOC and no practical component shall be required. The marksheets of the MOOC shall have to be submitted to the school for onward transmission to the Examinations division of the University to include in the records of examinations and count the credits accrued (as 4 credits) together with the marks. These marks shall be reflected in the marksheets of the 7th semester. The student has to seek permission for the MOOC course / paper option by the end of the 6th semester. The marksheets issued by the MOOCs authority have to be submitted by the student within 12 weeks of completion of classes of the 7th semester. Failure to do so, shall imply the student is **absent** in the allowed paper through MOOCs. The student must specify which theory + practical paper the student wishes to replace through MOOC paper, and only in lieu of that combination, the students request shall be considered. The MOOC paper must be of at least 4 credits.

Seventh Semester (Internship Route)#					
Group	Code	Paper	L	P	Credits
Internship	PC 485 ¹	Internship Report – I and Viva Voce #	-	-	10
	PC 489 ¹	Internship – I Progress Evaluation**	-	-	6
Practical/ Viva Voce					
PC	PC 483	Minor Project ¹	-	-	8
AEC	PC 481	* Summer Training (after 6 th Sem) Report	-	-	2
Total			-	-	26

¹ Mandatory Paper, this paper must be passed by the student for award of the degree. The student shall be allocated a supervisor / guide for project work at the end of 6th semester by the School, 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 back-ground 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 the concerned supervisor while the term end examinations 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 Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school.

Students are allowed to do internship in this semester, if following this route for the award of the degree. 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. An internal mentor shall also be assigned by the school. The student shall continue on this route for completion of the requirements of the degree in the final semester. However, the APC of the school may allow change of route to the "Regular Route" in the eighth semester, but students changing their route from "Internship Route" to "Regular Route", in the eight semester, shall not be eligible for award of minor specialization(s) and / or Honours.

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

** NUES: Evaluation by a committee of teachers, constituted by the Academic Programme Committee, out of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

Internship Viva Voce: Evaluation shall be conducted of 40 marks (Teachers' continuous evaluation / internal assessment) by the mentor (internal and/or external). And, 60 marks by a bench of the internal mentor and the external examiner deputed by examinations division(COE), for a total of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

Seventh Semester (Research Route)#					
Group	Code	Paper	L	P	Credits
Research	PC 491 ¹	Research Work Report – I and Viva Voce [#]	-	-	18
	PC 495 ¹	Research Work – I Progress Evaluation**	-	-	6
Practical/ Viva Voce					
AEC	PC 481	* Summer Training (after 6 th Sem) Report	-	-	2
Total			-	-	22

Students are allowed to do academic research in this semester, if following this route for the award of the degree. The students allowed to proceed for this route shall be required to submit a report (ICT491). The report has to be countersigned by the mentor concerned. Marks out of 40 have to awarded by the mentor (on a performa to be provided by the school) and submitted confidentially to the school (this may be done through email). The same has to be countersigned by the mentor at the organization where internship is completed. The format of the report shall be specified by the school. The student shall continue on this route for completion of the requirements of the degree in the final semester. However, the APC of the school may allow change of route to the "Regular Route" in the eighth semester, but students changing their route from "Research Route" to "Regular Route", in the eight semester, shall not be eligible for award of minor specialization(s) minor specialization(s) and / or Honours.

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

*NUES: Evaluation by the committee of teachers, constituted by the Academic Programme Committee, out of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

B.Tech/M.Tech Dual Degree

Eighth Semester					
Group	Code	Paper	L	P	Credits
Regular Route					
Project	PC 402 ¹	Major Project – Report and Viva Voce	-	-	20
	PC 406 ¹	Major Project Progress Evaluation*	-	-	6
Internship Route					
Internship	PC 408 ¹	Internship Report – II	-	-	8
	PC 412 ¹	Internship Progress Evaluation*	-	-	4
Project	PC 414 ¹	Major Project – Report			10
	PC 418 ¹	Major Project Progress Evaluation*			6
Research Route					
Research	PC 420 ¹	Thesis** and Viva Voce	-	-	20
	PC 424 ¹	Research Work Progress Evaluation*	-	-	6
Total			-	-	26

Note: The student continues with the degree route as completed in the seventh semester. However, the APC of the school may allow changes within the scope of this document.

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

** Submission of the thesis is to be allowed only if a paper has been accepted / published in a Scopus /Web of Science indexed conference / journal.

In the absence of the supervisor, the Dean of the School can assign the responsibility of the supervisor to any faculty of the school.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

PROGRAMME CORE ELECTIVE PAPERS

Paper	Paper Code	Paper Name	T	P	Credits
Semester 5: Choose any one paper					
PE331	PE 331T	Digital Signal Processing	3	-	3
	PE 331P	Digital Signal Processing Lab	-	2	1
PE333	PE333T	Natural Language Processing	3	-	3
	PE333P	Natural Language Processing Lab	-	2	1
Semester 6: Choose any two papers (One paper from each Group)					
GROUP 1(Choose 1)					
PE332	PE 332T	Computational Optimization	3	-	3
	PE 332P	Computational Optimization Lab	-	2	1
PE334	PE 334T	Mobile Ad hoc Networks	3	-	3
	PE 334P	Mobile Ad hoc Networks Lab	-	2	1
PE336	PE 336T	Digital Image Processing	3	-	3
	PE 336P	Digital Image Processing Lab	-	2	1
PE352	PE 352T	Fuzzy Sets and Fuzzy Logic	3	-	3
	PE 352P	Fuzzy Sets and Fuzzy Logic	-	2	1
PE354	PE 354T	Information Theory and Coding	4	-	4
PE356	PE 356T	Cloud Computing	4	-	4
PE358	PE 358T	Quantum Computing	4	-	4
GROUP 2(Choose 1)					
PE342	PE 342T	Semantic Web	3	-	3
	PE 342P	Semantic Web Lab	-	2	1
PE344	PE 344T	Software Project Management	3	-	3
	PE 344P	Software Project Management Lab	-	2	1
PE360	PE 360T	Cyber Security and Forensics	4	-	4
PE362	PE 362T	Mobile Computing	3	-	3
	PE 362P	Mobile Computing Lab	-	2	1
PE364	PE 364T	E-Commerce	4	-	4
PE366	PE 366T	Introduction to IoT	3	-	3
	PE 366P	Introduction to IoT Lab	-	2	1

Scheme

Bachelor of Technology / Master of Technology (Dual Degree Programmes)

In

b. Information Technology – Major Discipline

B.Tech/M.Tech Dual Degree

First Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
ES	ES-101	Programming for Problem Solving	4	-	4
ES	ES-103/ ES-105	*Any one of the following: Basics of Electrical Engineering/ Basics of Electronics Engineering	3	-	3
BS	BS-107	Engineering Mathematics – I	4	-	4
BS	BS-109/ BS-111	*Any one of the following: Engineering Chemistry/ Engineering Physics	3	-	3
ES/ AEC	ES-113/ AEC-115	*Any one of the following: Engineering Mechanics/ Communication Skills	3	-	3
VAC	VAC-117	*Indian Constitution	2	-	2
VAC	VAC-119	**Human Values & Ethics	2	-	2
Practical/ Viva Voce					
ES	ES-151	Programming for Problem Solving Lab	-	2	1
ES	ES-153/ ES-155	*Any one of the following corresponding to the theory paper offered: Basics of Electrical Engineering Lab/ Basics of Electronics Engineering Lab	-	2	1
BS	BS-157/ BS-159	*Any one of the following corresponding to the theory paper offered: Engineering Chemistry Lab/Engineering Physics Lab	-	2	1
Total			21	6	24

Group	Code	Paper	L	P	Credits
VAC		**NSS/NCC/Cultural Clubs/Technical Society/ Technical Club/Institution's Innovation Council	-	-	2
VAC	VAC-161	***Environment Studies	-	-	0

Note: Orientation/ Student Induction program will be offered to the students, right at the start of the first semester.

* 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 school shall decide which paper to offer in which semester.

*This is an NUES paper.

**This is an NUES paper. Every student is required to complete this paper of at least 2 credits through SWAYAM / NPTEL MOOCs platform, with the approval of the Dean, USIC&T. If the student completes a course with the higher number of credits from SWAYAM / NPTEL MOOCs platform, the credits reflected in the university marksheet shall be only 2 credits. The marksheet of successfully completing the paper/course with at least 40% marks has to be submitted to the school by the end of the 6th semester (3rd year) of studies. The cost of the paper/course including its examination fee is to be borne by the student. The clearance of the paper/course is mandatory for the award of the degree. The result of this subject shall be incorporated in the 6th semester marksheet.

****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.

*****Non-credit:** Every student is required to complete an Environmental Studies paper of at least 2 credits through SWAYAM / NPTEL MOOCs platform with the approval of Dean, USIC&T. This shall be considered as a non-credit paper/course. The marksheet of successfully completing the paper/course with at least 40% marks has to be submitted to the school by the end of the 6th semester (3rd year) of studies. The cost of the paper/course including its examination fee is to be borne by the student. The clearance of the paper/course is mandatory for the award of the degree.

B.Tech/M.Tech Dual Degree

Second Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
ES	ES-102	Data Structures	4	-	4
SEC	SEC-104	Python Programming	4	-	4
ES	ES-106/ ES-108	*Any one of the following: Basics of Electrical Engineering/ Basics of Electronics Engineering	3	-	3
BS	BS-110	Engineering Mathematics – II	4	-	4
BS	BS-112/ BS-114	*Any one of the following: Engineering Physics/ Engineering Chemistry	3	-	3
ES/ AEC	ES-116/ AEC-118	*Any one of the following: Engineering Mechanics/ Communication Skills	3	-	3
Practical/ Viva Voce					
ES	ES-152	Data Structures Lab	-	2	1
SEC	SEC-154	Python Programming Lab	-	2	1
ES	ES-156/ ES-158	*Any one of the following corresponding to the theory paper offered: Basics of Electrical Engineering Lab/ Basics of Electronics Engineering Lab	-	2	1
BS	BS-160/ BS-162	*Any one of the following corresponding to the theory paper offered: Engineering Physics Lab/ Engineering Chemistry Lab	-	2	1
Total			21	8	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 school shall decide which paper to offer in which semester.

BRIDGE COURSE FOR LATERAL ENTRY STUDENTS

Provision for Lateral Entry of Students

Lateral entry of students shall be allowed as per University rules, regulations and policy. These students shall be admitted in the second year of the degree programme. Such students shall study the papers / courses offered from the second year onwards only. Only the credits earned for the papers of second to fourth year of the programme of study shall be considered for the award of the degree to the lateral entry students. In addition to these papers/course of second to fourth year of study, these students have to study two papers / courses, namely (first time offered in the 3rd semester):

Paper Code	Paper Name	L/P
BC-001	Bridge Course in Mathematics	4
BC-002	Bridge Course in Programming in C	4

Implementation Rules for Bridge Courses:

1. The Class incharges for the third semester of the batch (appointed by the Dean, USICT) shall act as the mentor of the lateral entry students for these courses.
2. These papers have to be qualified by the students. The students shall study the bridge course in self-study mode under the mentorship of the mentors.
3. For these papers examination shall be conducted by the concerned subject teacher / mentor 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 marksheets will be issued by the Examination Division of the University for the Bridge Course.
7. Students shall study the paper in the self study mode. A Mentor shall be allocated by the academic programme committee of the School to groups of lateral entry students. Mentors shall interact with the students to clarify, guide, assignments (given by the mentor) and evaluation of the course.

B.Tech/M.Tech Dual Degree

Third Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-201	Computer Organization and Architecture	4	-	4
PC	PC-203	Database Management Systems	3	-	3
PC	PC-205	Object Oriented Programming using Java	4	-	4
PC	PC-207	Design and Analysis of Algorithms	4	-	4
PC	PC-209	Operating Systems	3	-	3
AEC	AEC-211/ AEC-213	*Any one of the following: Principles of Management/ Engineering Economics	2	-	2
Practical/ Viva Voce					
PC	PC-251	Database Management Systems Lab	-	2	1
PC	PC-253	Object Oriented Programming using Java Lab	-	2	1
PC	PC-255	Design and Analysis of Algorithms Lab	-	2	1
PC	PC-257	Operating Systems Lab	-	2	1
PC	PC-259	Term Paper – I**			2
Total			20	8	26

*For a particular batch of a programme of study one out of these two papers shall be taught in the third semester while the other shall be taught in the 4th semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 3rd semester and similarly for the students who study the paper in the fourth semester. The school shall decide which paper to offer in which semester.

**NUES: The paper is an NUES paper. The concerned teacher to evaluate out of 100

B.Tech/M.Tech Dual Degree

Fourth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-202	Theory of Computation	4	-	4
PC	PC-204	Software Engineering	3	-	3
PC	PC-206	Computer Networks	4	-	4
PC	PC-208	Artificial Intelligence & Machine Learning	4	-	4
PC	PC-210	Web Technologies	3	-	3
AEC	AEC-212/ AEC-214	*Any one of the following: Engineering Economics/ Principles of Management	2	-	2
Practical/ Viva Voce					
PC	PC-252	Software Engineering Lab	-	2	1
PC	PC-254	Computer Networks Lab	-	2	1
PC	PC-256	Artificial Intelligence & Machine Learning Lab	-	2	1
PC	PC-258	Web Technologies Lab	-	2	1
PC	PC-260	Term Paper – II*			2
Total			22	8	26

*For a particular batch of a programme of study one out of these two papers shall be taught in the third semester while the other shall be taught in the 4th semester. Students who have to re-appear can only reappear in the odd semester if originally offered to the student in the 3rd semester and similarly for the students who study the paper in the fourth semester. The school shall decide which paper to offer in which semester.

Note: The minor specializations are offered through the following routes:

- j. Program Electives (PE): Electives that may be chosen as per the list specified in this document. These papers may be a part of other elective groups offered to the students. If it is a part of the student's minor specialization elective group, then the students cannot take the paper in this part of the scheme of studies.
- k. Program Core Electives (PCE): Groups of 5 courses / papers are offered for specific minor specialization groups.
- l. Emerging Area Elective (EAE) or Open Area Elective Group (OAE): Groups of 5 courses / papers are offered for specific minor specialization groups. These specialization groups are offered by USICT as detailed in this document. Or, they may be offered by other schools of the University at the Dwarka campus of the University. These groups, if offered by other schools shall be called Open elective groups / minor specializations. The open elective groups must be offered as per the framework specified in this document.

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Fifth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-303	Compiler Design	3	-	3
PC	PC-305	Programming in C++	3	-	3
PE		Elective – 1	4	-	4
PCE		#Elective PCE 1 (students to choose one group)	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school – 1 (students to choose 1 group)	4	-	4
VAC*	PC-301	Technical and Scientific Writing	2	-	2
Practical/ Viva Voce					
PC	PC-397	Summer Training (after 4 th semester) Report	-	-	2
PC	PC-399	Term Paper – III*	-	-	2
PC	PC-321	Compiler Design Lab		2	1
PC	PC-323	Programming in C++ Lab		2	1
Total			20	4	26

* NUES

#Students may choose from one group for a minor specialization (that is one group of papers for programme core elective (PCE) based minor specialization and the other for emerging area elective (EAE) based specializations or Open areas elective groups offered by the School or other schools (as per the pattern of group formation in this scheme). Such courses/papers (even in subsequent semesters), if they have a practical component, then the course shall be divided into two separate components. A theory component paper with a unique paper code with 3 credits and a practical component paper with another unique paper code with 1 credit. However, if there is no practical component, then the course / paper shall be a pure theory paper with 4 credits. Minor specialization is awarded only if all 20 credits are awarded / earned from the group of minor specialization chosen. The school shall offer the electives based on availability of resources in the school

B.Tech/M.Tech Dual Degree

Sixth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PE		Elective – 2	4	-	4
PE		Elective – 3	4	-	4
PCE		Elective PCE2	4	-	4
PCE		Elective PCE3	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school –2	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school –3	4	-	4
Practical/ Viva Voce					
VAC	VAC-398	** NSS/NCC/Cultural Clubs/Technical Society/ Technical Club/Institution's Innovation Council	-	-	2
Total			24		26

** NUES

Note: The route for the award of the degree has to be chosen by the student at the end of the 6th semester or the 3rd year. That is, the students shall be allowed to choose from one of the following three routes, for the award of the degree:

- j. **Regular route:** The students taking this route shall continue with the study of the courses / papers in the 7th semester of 24 credits and a project or internship in the 8th semester. This route may lead to the award of two minor specializations.
- k. **Internship route:** The students taking this route shall be required to undergo Internship at an organization. The organization shall offer an Internship to the student. The Internship offer shall be through the Training and Placement officer of the school, only. Students shall not be allowed to accept an Internship through any route. The students shall be required to submit an internship report in both the 7th and 8th semester. The reports shall contain the journal kept by the student summarizing weekly work done, countersigned by the mentor allocated by the Internship mentor at

the Organization. There shall an internal teacher also allocated to the student as a mentor for the Internship progress guidance and evaluation.

- I. **Research route:** The students taking this route be required to join research internship under mentorship of an academician at an organization. The topic of work of the student and the mentor (including the organization) shall be approved by the APC of the school. The student is required to publish at least one conference paper in a reputed conference / journal (meaning thereby, that its proceeding (if it is a conference) or the paper shall be indexed in Web of Science and/or Scopus) before the submission of the 8th semester dissertation. The research route is to be allowed only to students who have no “fail” paper till 6th semester, that is, all papers upto and including 6th semester have been passed by the student and after 6th semester the student has a CGPA of 7.5 or more.

B.Tech/M.Tech Dual Degree

Seventh Semester (Regular Route)					
Group	Code	Paper	L	P	Credits
Theory Papers					
PCE		Core area Elective PCE – 4 / MOOC ²	4	-	4
PCE		Core area Elective PCE – 5 / MOOC ²	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school – 4/ MOOC ²	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school – 5/ MOOC ²	4	-	4
Practical/ Viva Voce					
PC	PC 483	Minor Project ¹	-	-	8
PC	PC 481	Summer Training (after 6 th Semester) Report*	-	-	2
Total					26

* NUES

¹ Mandatory Paper, this paper must be passed by the student for award of the degree. The student shall be allocated a supervisor / guide for project work at the end of 6th semester by the School, 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 back-ground 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 the concerned supervisor while the term end examinations 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 Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school. However, the APC of the school may allow change of route from the "Regular Route" to "Internship Route" in the eighth semester, but students changing their route to "Internship Route", in the eight semester shall not be eligible for the award of the Honours degree.

² The student is allowed to do the elective through MOOCs (Massive Open Online Courses) offered through SWAYAM / NPTEL platform. For this purpose, the student must apply to the school for doing the elective course through MOOC. Only with the approval of the DEAN, USICT, the student may attend the course. All cost for attending and examinations have to be borne by the student. Such courses shall be of 4 or more credits (but shall be accounted for as 4 credits only). The marksheets of the MOOC shall have to be submitted to the school for onward transmission to the Examinations division of the University to include in the records of examinations and count the credits accrued (as 4 credits) together with the marks. These marks shall be reflected in the marksheets of the 7th semester. The student has to seek permission for the MOOC course / paper option by the end of the 6th semester. The marksheets issued by the MOOCs authority have to be submitted by the student within 12 weeks of completion of classes of the 7th semester. Failure to do so, shall imply the student is **absent** in the allowed paper through MOOCs.

Seventh Semester (Internship Route)#					
Group	Code	Paper	L	P	Credits
Internship	PC 485 ¹	Internship Report – I and Viva Voce #	-	-	10
	PC 489 ¹	Internship – I Progress Evaluation**	-	-	6
Practical/ Viva Voce					
PC	PC 483	Minor Project ¹	-	-	8
AEC	PC 481	* Summer Training (after 6 th Sem) Report	-	-	2
Total			-	-	26

¹ Mandatory Paper, this paper must be passed by the student for award of the degree. The student shall be allocated a supervisor / guide for project work at the end of 6th semester by the School, 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 back-ground 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 the concerned supervisor while the term end examinations 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 Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school.

Students are allowed to do internship in this semester, if following this route for the award of the degree. 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. An internal mentor shall also be assigned by the school. The student shall continue on this route for completion of the requirements of the degree in the final semester. However, the APC of the school may allow change of route to the "Regular Route" in the eighth semester, but students changing their route from "Internship Route" to "Regular Route", in the eight semester, shall not be eligible for award of minor specialization(s) and / or Honours.

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

** NUES: Evaluation by a committee of teachers, constituted by the Academic Programme Committee, out of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

Internship Viva Voce: Evaluation shall be conducted of 40 marks (Teachers' continuous evaluation / internal assessment) by the mentor (internal and/or external). And, 60 marks by a bench of the internal mentor and the external examiner deputed by examinations division(COE), for a total of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

Seventh Semester (Research Route)#					
Group	Code	Paper	L	P	Credits
Research	PC 491 ¹	Research Work Report – I and Viva Voce [#]	-	-	18
	PC 495 ¹	Research Work – I Progress Evaluation**	-	-	6
Practical/ Viva Voce					
AEC	PC 481	* Summer Training (after 6 th Sem) Report	-	-	2
Total			-	-	22

Students are allowed to do academic research in this semester, if following this route for the award of the degree. The students allowed to proceed for this route shall be required to submit a report (ICT491). The report has to be countersigned by the mentor concerned. Marks out of 40 have to awarded by the mentor (on a performa to be provided by the school) and submitted confidentially to the school (this may be done through email). The same has to be countersigned by the mentor at the organization where internship is completed. The format of the report shall be specified by the school. The student shall continue on this route for completion of the requirements of the degree in the final semester. However, the APC of the school may allow change of route to the "Regular Route" in the eighth semester, but students changing their route from "Research Route" to "Regular Route", in the eight semester, shall not be eligible for award of minor specialization(s) minor specialization(s) and / or Honours.

*NUES: Evaluation by the committee of teachers, constituted by the Academic Programme Committee, out of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

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Eighth Semester					
Group	Code	Paper	L	P	Credits
Regular Route					
Project	PC 402 ¹	Major Project – Report and Viva Voce	-	-	20
	PC 406 ¹	Major Project Progress Evaluation*	-	-	6
Internship Route					
Internship	PC 408 ¹	Internship Report – II	-	-	8
	PC 412 ¹	Internship Progress Evaluation*	-	-	4
Project	PC 414 ¹	Major Project – Report			10
	PC 418 ¹	Major Project Progress Evaluation*			6
Research Route					
Research	PC 420 ¹	Thesis** and Viva Voce	-	-	20
	PC 424 ¹	Research Work Progress Evaluation*	-	-	6
Total			-	-	26

Note: The student continues with the degree route as completed in the seventh semester. However, the APC of the school may allow changes within the scope of this document.

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

** Submission of the thesis is to be allowed only if a paper has been accepted / published in a Scopus /Web of Science indexed conference / journal.

In the absence of the supervisor, the Dean of the School can assign the responsibility of the supervisor to any faculty of the school.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

PROGRAMME CORE ELECTIVE PAPERS

Paper	Paper Code	Paper Name	T	P	Credits
Semester 5: Choose any one paper					
PE331	PE 331T	Digital Signal Processing	3	-	3
	PE 331P	Digital Signal Processing Lab	-	2	1
PE333	PE333T	Natural Language Processing	3	-	3
	PE333P	Natural Language Processing Lab	-	2	1
Semester 6: Choose any two papers (One paper from each Group)					
GROUP 1(Choose 1)					
PE332	PE 332T	Computational Optimization	3	-	3
	PE 332P	Computational Optimization Lab	-	2	1
PE334	PE 334T	Mobile Ad hoc Networks	3	-	3
	PE 334P	Mobile Ad hoc Networks Lab	-	2	1
PE336	PE 336T	Digital Image Processing	3	-	3
	PE 336P	Digital Image Processing Lab	-	2	1
PE338	PE 338T	Random Processes and Stochastic System	4	-	4
PE340	PE 340T	Network Security and Cryptography	3	-	3
	PE 340P	Network Security and Cryptography Lab	-	2	1
PE342	PE 342T	Fuzzy Sets and Fuzzy Logic	3	-	3
	PE 342P	Fuzzy Sets and Fuzzy Logic	-	2	1
PE344	PE 344T	Information Theory and Coding	4	-	4
PE346	PE 346T	Cloud Computing	4	-	4
PE348	PE 348T	Quantum Computing	4	-	4
GROUP 2(Choose 1)					
PE350	PE 350T	Semantic Web	3	-	3
	PE 350P	Semantic Web Lab	-	2	1
PE352	PE 352T	Software Project Management	3	-	3
	PE 352P	Software Project Management Lab	-	2	1
PE356	PE 356T	Data Warehousing and Business Intelligence	3	-	3
	PE 356P	Data Warehousing and Business Intelligence Lab	-	2	1
PE358	PE 358T	Unsupervised Learning	3	-	3
	PE 358P	Unsupervised Learning Lab	-	2	1
PE360	PE 360T	Advanced Java Programming	3	-	3
	PE 360P	Advanced Java Programming Lab.	-	2	1
PE362	PE 362T	Cyber Security and Forensics	4	-	4
PE364	PE 364T	Mobile Computing	3	-	3
	PE 364P	Mobile Computing Lab	-	2	1
PE366	PE 366T	E-Commerce	4	-	4
PE368	PE 368T	Introduction to IoT	3	-	3
	PE 368P	Introduction to IoT Lab	-	2	1

MINOR SPECIALIZATION STREAMS

(Programme Core Elective Streams)

These papers / streams shall be offered as per the prerequisite specified. The papers are to be offered to at the undergraduate level to the students of Undergraduate part of the Dual Degree programme. A course/ paper is identified by the code allocated. A course may be split in to a theory component which shall have the letter 'T' attached while its practical component shall have the letter 'P' suffixed. A student has to study both the theory and the practical component, of a course, if taken as an elective.

Programme Core Elective Group: Minor Specialization in Software Engineering and DevOps

Code	PaperCode	Paper	L	P	Credits	Semester
PCE349	PCE 349T	Advanced Software Architecture and System Design	3	-	3	5 th
	PCE 349P	Advanced Software Architecture and System Design Lab	-	2	1	
PCE374	PCE 374T	Software Testing, Verification and Validation	3	-	3	6 th
	PCE 374P	Software Testing, Verification and Validation Lab	-	2	1	
PCE376	PCE 376T	DevOps and Continuous Delivery	3	-	3	6 th
	PCE 376P	DevOps and Continuous Delivery Lab	-	2	1	
PCE401	PCE 401T	Secure Software Engineering	3	-	3	7 th
	PCE 401P	Secure Software Engineering Lab	-	2	1	
PCE405	PCE405T	Software Project Management and Engineering Economics	3	-	3	7 th
	PCE405P	Software Project Management and Engineering Economics Lab	-	2	1	

Note: The students opting for this group cannot take the papers PE352 Programme Electives

Programme Core Elective Group: Minor Specialization in Software Engineering

Code	PaperCode	Paper	L	P	Credits	Semester
PCE349	PCE 349T	Advanced Software Architecture and System Design	3	-	3	5 th
	PCE 349P	Advanced Software Architecture and System Design Lab	-	2	1	
PCE378	PCE 378T	Software Requirements and Estimation	3	-	3	6 th
	PCE 378P	Software Requirements and Estimation Lab	-	2	1	
PCE374	PCE 374T	Software Testing, Verification and Validation	3	-	3	6 th
	PCE 374P	Software Testing, Verification and Validation Lab	-	2	1	
PCE407	PCE 407T	Software Metrics and Predictive Modelling	3	-	3	7 th
	PCE 407P	Software Metrics and Predictive Modelling Lab	-	2	1	
PCE401	PCE 401T	Secure Software Engineering	3	-	3	7 th
	PCE 401P	Secure Software EngineeringLab	-	2	1	

Note: The students opting for this group cannot take the papers PE352 as Programme Electives

Complexity

Papers:

1. Advanced Design and Analysis of Algorithms
2. Approximation and Randomized Algorithms
3. Computational Complexity Theory
4. Graph Algorithms
5. Parallel and Distributed Algorithms

2. Systems and Infrastructure Engineering

Papers:

1. Advanced Operating Systems
2. Distributed Systems
3. Cloud and Edge Computing
4. Storage Systems and File Systems
5. Performance Engineering

MINOR SPECIALIZATION STREAMS (EMERGING AREA ELECTIVE GROUPS)

Emerging Area Elective Group: Minor Specialization in Artificial Intelligence

Code	PaperCode	Paper	L	P	Credits	Semester
EAE355	EAE 355T	Statistics and Statistical Modelling	3	-	3	5 th
	EAE 355P	Statistics and Statistical Modelling Lab	-	2	1	
EAE388	EAE 388T	Advanced Machine Learning	3	-	3	6 th
	EAE 388P	Advanced Machine Learning Lab	-	2	1	
EAE390	EAE 390T	Introduction to Data Analytics and Data Visualisation	3	-	3	6 th
	EAE 390P	Introduction to Data Analytics and Data Visualisation Lab	-	2	1	
EAE415	EAE 415T	Large Language Models and Generative AI	3	-	3	7 th
	EAE 415P	Large Language Models and Generative AI Lab	-	2	1	
EAE417	EAE 417T	Deep Learning and Reinforcement Learning	3	-	3	7 th
	EAE 417P	Deep Learning and Reinforcement Learning Lab	-	2	1	

Note: The students opting for this group cannot take the papers PE335, PE337, PE341, PE358 as Programme Electives

Emerging Area Elective Group: Minor Specialization in Data Science

Code	PaperCode	Paper	L	P	Credits	Semester
EAE 355	EAE 355T	Statistics and Statistical Modelling	3	-	3	5 th
	EAE 355P	Statistics and Statistical Modelling Lab	-	2	1	
EAE 388	EAE 388T	Advanced Machine Learning	3	-	3	6 th
	EAE 388P	Advanced Machine Learning Lab	-	2	1	
EAE 390	EAE 390T	Introduction to Data Analytics and Data Visualisation	3	-	3	6 th
	EAE 390P	Introduction to Data Analytics and Data Visualisation Lab	-	2	1	
EAE 419	EAE 419T	Data Warehousing and Business Intelligence	3	-	3	7 th
	EAE 419P	Data Warehousing and Business Intelligence Lab	-	2	1	
EAE 413	EAE 413T	Big Data Analytics	3	-	3	7 th
	EAE 413P	Big Data Analytics Lab	-	2	1	

Note: The students opting for this group cannot take the papers PE335, PE337, PE341, PE356, PE358 as Programme Electives

MINOR SPECIALIZATION STREAMS (OPEN AREA ELECTIVE GROUPS)

Open Area Elective Group: Minor Specialization in Internet of Things

Code	PaperCode	Paper	L	P	Credits	Semester
OAE 361	OAE 361T	Introduction to IoT	3	-	3	5th
	OAE 361P	Introduction to IoT Lab	-	2	1	
OAE 304	OAE 304T	Embedded Systems	3	-	3	6th
	OAE 304P	Embedded Systems Lab	-	2	1	
OAE 306	OAE 306T	Wireless Sensor Networks	3	-	3	6th
	OAE 306P	Wireless Sensor Networks Lab	-	2	1	
OAE 429	OAE 429T	Edge and Fog Computing	3	-	3	7th
	OAE 429P	Edge and Fog Computing Lab	-	2	1	
OAE 431	OAE 431T	Industrial IoT	3	-	3	7th
	OAE 431P	Industrial IoT Lab	-	2	1	

Note: The students opting for this group cannot take the papers PE368 as Programme Electives

Scheme

Bachelor of Technology / Master of Technology (Dual Degree Programmes)

In

- c. Electronics and Communications Engineering – Major Discipline**

B.Tech/M.Tech Dual Degree

First Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
ES	ES-101	Programming for Problem Solving	4	-	4
ES	ES-103/ ES-105	*Any one of the following: Basics of Electrical Engineering/ Basics of Electronics Engineering	3	-	3
BS	BS-107	Engineering Mathematics – I	4	-	4
BS	BS-109/ BS-111	*Any one of the following: Engineering Chemistry/ Engineering Physics	3	-	3
ES/ AEC	ES-113/ AEC-115	*Any one of the following: Engineering Mechanics/ Communication Skills	3	-	3
VAC	VAC-117	*Indian Constitution	2	-	2
VAC	VAC-119	**Human Values & Ethics	2	-	2
Practical/ Viva Voce					
ES	ES-151	Programming for Problem Solving Lab	-	2	1
ES	ES-153/ ES-155	*Any one of the following corresponding to the theory paper offered: Basics of Electrical Engineering Lab/ Basics of Electronics Engineering Lab	-	2	1
BS	BS-157/ BS-159	*Any one of the following corresponding to the theory paper offered: Engineering Chemistry Lab/Engineering Physics Lab	-	2	1
Total			21	6	24

Group	Code	Paper	L	P	Credits
VAC		**NSS/NCC/Cultural Clubs/Technical Society/ Technical Club/Institution's Innovation Council	-	-	2
VAC	VAC-161	***Environment Studies	-	-	0

Note: Orientation/ Student Induction program will be offered to the students, right at the start of the first semester.

* 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 school shall decide which paper to offer in which semester.

*This is an NUES paper.

**This is an NUES paper. Every student is required to complete this paper of at least 2 credits through SWAYAM / NPTEL MOOCs platform, with the approval of the Dean, USIC&T. If the student completes a course with the higher number of credits from SWAYAM / NPTEL MOOCs platform, the credits reflected in the university marksheet shall be only 2 credits. The marksheet of successfully completing the paper/course with at least 40% marks has to be submitted to the school by the end of the 6th semester (3rd year) of studies. The cost of the paper/course including its examination fee is to be borne by the student. The clearance of the paper/course is mandatory for the award of the degree. The result of this subject shall be incorporated in the 6th semester marksheet.

****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.

*****Non-credit:** Every student is required to complete an Environmental Studies paper of at least 2 credits through SWAYAM / NPTEL MOOCs platform with the approval of Dean, USIC&T. This shall be considered as a non-credit paper/course. The marksheets of successfully completing the paper/course with at least 40% marks has to be submitted to the school by the end of the 6th semester (3rd year) of studies. The cost of the paper/course including its examination fee is to be borne by the student. The clearance of the paper/course is mandatory for the award of the degree.

B.Tech/M.Tech Dual Degree

Second Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
ES	ES-102	Data Structures	4	-	4
SEC	SEC-104	Python Programming	4	-	4
ES	ES-106/ ES-108	*Any one of the following: Basics of Electrical Engineering/ Basics of Electronics Engineering	3	-	3
BS	BS-110	Engineering Mathematics – II	4	-	4
BS	BS-112/ BS-114	*Any one of the following: Engineering Physics/ Engineering Chemistry	3	-	3
ES/ AEC	ES-116/ AEC-118	*Any one of the following: Engineering Mechanics/ Communication Skills	3	-	3
Practical/ Viva Voce					
ES	ES-152	Data Structures Lab	-	2	1
SEC	SEC-154	Python Programming Lab	-	2	1
ES	ES-156/ ES-158	*Any one of the following corresponding to the theory paper offered: Basics of Electrical Engineering Lab/ Basics of Electronics Engineering Lab	-	2	1
BS	BS-160/ BS-162	*Any one of the following corresponding to the theory paper offered: Engineering Physics Lab/ Engineering Chemistry Lab	-	2	1
Total			21	8	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 school shall decide which paper to offer in which semester.

BRIDGE COURSE FOR LATERAL ENTRY STUDENTS

Provision for Lateral Entry of Students

Lateral entry of students shall be allowed as per University rules, regulations and policy. These students shall be admitted in the second year of the degree programme. Such students shall study the papers / courses offered from the second year onwards only. Only the credits earned for the papers of second to fourth year of the programme of study shall be considered for the award of the degree to the lateral entry students. In addition to these papers/course of second to fourth year of study, these students have to study two papers / courses, namely (first time offered in the 3rd semester):

Paper Code	Paper Name	L/P
BC-001	Bridge Course in Mathematics	4
BC-002	Bridge Course in Programming in C	4

Implementation Rules for Bridge Courses:

1. The Class incharges for the third semester of the batch (appointed by the Dean, USICT) shall act as the mentor of the lateral entry students for these courses.
2. These papers have to be qualified by the students. The students shall study the bridge course in self-study mode under the mentorship of the mentors.
3. For these papers examination shall be conducted by the concerned subject teacher / mentor 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.
7. Students shall study the paper in the self study mode. A Mentor shall be allocated by the academic programme committee of the School to groups of lateral entry students. Mentors shall interact with the students to clarify, guide, assignments (given by the mentor) and evaluation of the course.

B.Tech/M.Tech Dual Degree

Third Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-201	Computer Organization & Architecture	4	-	4
PC	PC-211	Signals and Systems	3	-	3
PC	PC-213	Network Analysis & Synthesis	4	-	4
PC	PC-215	Analog Devices & Circuits	4	-	4
PC	PC-217	Analog Communications	3	-	3
AEC	AEC-211	Principles of Management	2	-	2
Practical/ Viva Voce					
PC	PC-261	Signals and Systems Lab	-	2	1
PC	PC-263	Network Analysis & Synthesis Lab	-	2	1
PC	PC-265	Analog Devices & Circuits Lab	-	2	1
PC	PC-267	Analog Communications Lab	-	2	1
PC	PC-259	Term Paper – I**			2
Total			20	8	26

**NUES: The paper is an NUES paper. The concerned teacher to evaluate out of 100

B.Tech/M.Tech Dual Degree

Fourth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-212	Engineering Electromagnetics	3	-	3
PC	PC-214	Digital Communication	3	-	3
PC	PC-206	Computer Networks	4	-	4
PC	PC-216	Linear Integrated Circuits	4	-	4
PC	PC-218	Digital Systems Design	4	-	4
AEC	AEC-212	Engineering Economics	2	-	2
Practical/ Viva Voce					
PC	PC-262	Digital Communication Lab	-	2	1
PC	PC-264	Linear Integrated Circuits Lab	-	2	1
PC	PC-266	Digital Systems Design Lab	-	2	1
PC	PC-254	Computer Networks Lab	-	2	1
PC	PC-260	Term Paper – II**			2
Total			20	8	26

B.Tech/M.Tech Dual Degree

Fifth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	EPC-303	Digital Signal Processing	3	-	3
PC	EPC-305	Microprocessors and Interfacing	3	-	3
PE		Elective – 1	4	-	4
PCE		#Elective PCE 1 (students to choose one group)	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school – 1 (students to choose 1 group)	4	-	4
VAC*	PC-301	Technical and Scientific Writing	2	-	2
Practical/ Viva Voce					
PC	PC-397	Summer Training (after 4 th semester) Report	-	-	2
PC	PC-399	Term Paper – III*	-	-	2
PC	PC-321	Digital Signal Processing Lab		2	1
PC	PC-323	Microprocessors and Interfacing Lab		2	1
Total			20	4	26

* NUES

#Students may choose from one group for a minor specialization (that is one group of papers for programme core elective (PCE) based minor specialization and the other for emerging area elective (EAE) based specializations or Open areas elective groups offered by the School or other schools (as per the pattern of group formation in this scheme). Such courses/papers (even in subsequent semesters), if they have a practical component, then the course shall be divided into two separate components. A theory component paper with a unique paper code with 3 credits and a practical component paper with another unique paper code with 1 credit. However, if there is no practical component, then the course / paper shall be a pure theory paper with 4 credits. Minor specialization is awarded only if all 20 credits are awarded / earned from the group of minor specialization chosen. The school shall offer the electives based on availability of resources in the school

B.Tech/M.Tech Dual Degree

Sixth Semester					
Group	Code	Paper	L	P	Credits
Theory Papers					
PC	PC-304	Control Systems	3	-	3
PE		Elective – 2	4	-	4
PCE		Elective PCE2	4	-	4
PCE		Elective PCE3	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school –2	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school –3	4	-	4
Practical/ Viva Voce					
PC	PC-306	Control Systems Lab		2	1
VAC	VAC-302	** NSS/NCC/Cultural Clubs/Technical Society/ Technical Club/Institution's Innovation Council	-	-	2
Total			24		26

** NUES

Note: The route for the award of the degree has to be chosen by the student at the end of the 6th semester or the 3rd year.
That is, the students shall be allowed to choose from one of the following three routes, for the award of the degree:

- m. **Regular route:** The students taking this route shall continue with the study of the courses / papers in the 7th semester of 24 credits and a project or internship in the 8th semester. This route may lead to the award of two minor specializations.
- n. **Internship route:** The students taking this route shall be required to undergo Internship at an organization. The organization shall offer an Internship to the student. The Internship offer shall be through the Training and Placement officer of the school, only. Students shall not be allowed to accept an Internship through any route. The students shall

be required to submit an internship report in both the 7th and 8th semester. The reports shall contain the journal kept by the student summarizing weekly work done, countersigned by the mentor allocated by the Internship mentor at the Organization. There shall an internal teacher also allocated to the student as a mentor for the Internship progress guidance and evaluation.

- o. **Research route:** The students taking this route be required to join research internship under mentorship of an academicians at an organization. The topic of work of the student and the mentor (including the organization) shall be approved by the APC of the school. The student is required to publish at least one conference paper in a reputed conference / journal (meaning thereby, that its proceeding (if it is a conference) or the paper shall be indexed in Web of Science and/or Scopus) before the submission of the 8th semester dissertation. The research route is to be allowed only to students who have no “fail” paper till 6th semester, that is, all papers upto and including 6th semester have been passed by the student and after 6th semester the student has a CGPA of 7.5 or more.

B.Tech/M.Tech Dual Degree

Seventh Semester (Regular Route)					
Group	Code	Paper	L	P	Credits
Theory Papers					
PCE		Core area Elective PCE – 4 / MOOC ²	4	-	4
PCE		Core area Elective PCE – 5 / MOOC ²	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school – 4/ MOOC ²	4	-	4
EAE/OAE		Elective from emerging area/ open elective offered by the school or other school – 5/ MOOC ²	4	-	4
Practical/ Viva Voce					
PC	PC 483	Minor Project ¹	-	-	8
PC	PC 481	Summer Training (after 6 th Semester) Report*	-	-	2
Total					26

* NUES

¹ Mandatory Paper, this paper must be passed by the student for award of the degree. The student shall be allocated a supervisor / guide for project work at the end of 6th semester by the School, 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 back-ground 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 the concerned supervisor while the term end examinations 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 Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school. However, the APC of the school may allow change of route from the "Regular Route" to "Internship Route" in the eighth semester, but students changing their route to "Internship Route", in the eighth semester shall not be eligible for the award of the Honours degree.

² The student is allowed to do the elective through MOOCs (Massive Open Online Courses) offered through SWAYAM / NPTEL platform. For this purpose, the student must apply to the school for doing the elective course through MOOC. Only with the approval of the DEAN, USICT, the student may attend the course. All cost for attending and examinations have to be borne by the student. Such courses shall be of 4 or more credits (but shall be accounted for as 4 credits only). The marks sheet of the MOOC shall have to be submitted to the school for onward transmission to the Examinations division of the University to include in the records of examinations and count the credits accrued (as 4 credits) together with the marks. These marks shall be reflected in the marks sheet of the 7th semester. The student has to seek permission for the MOOC course / paper option by the end of the 6th semester. The marks sheet issued by the MOOCs authority have to be submitted by the student within 12 weeks of completion of classes of the 7th semester. Failure to do so, shall imply the student is **absent** in the allowed paper through MOOCs.

Seventh Semester (Internship Route)#					
Group	Code	Paper	L	P	Credits
Internship	PC 485 ¹	Internship Report – I and Viva Voce #	-	-	10
	PC 489 ¹	Internship – I Progress Evaluation**	-	-	6
Practical/ Viva Voce					
PC	PC 483	Minor Project ¹	-	-	8
AEC	PC 481	* Summer Training (after 6 th Sem) Report	-	-	2
Total			-	-	26

¹ Mandatory Paper, this paper must be passed by the student for award of the degree. The student shall be allocated a supervisor / guide for project work at the end of 6th semester by the School, 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 back-ground 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 the concerned supervisor while the term end examinations 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 Dean of the school can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the school.

Students are allowed to do internship in this semester, if following this route for the award of the degree. 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. An internal mentor shall also be assigned by the school. The student shall continue on this route for completion of the requirements of the degree in the final semester. However, the APC of the school may allow change of route to the "Regular Route" in the eighth semester, but students changing their route from "Internship Route" to "Regular Route", in the eight semester, shall not be eligible for award of minor specialization(s) and / or Honours.

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

** NUES: Evaluation by a committee of teachers, constituted by the Academic Programme Committee, out of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

Internship Viva Voce: Evaluation shall be conducted of 40 marks (Teachers' continuous evaluation / internal assessment) by the mentor (internal and/or external). And, 60 marks by a bench of the internal mentor and the external examiner deputed by examinations division(COE), for a total of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

Seventh Semester (Research Route)#					
Group	Code	Paper	L	P	Credits
Research	PC 491 ¹	Research Work Report – I and Viva Voce#	-	-	18
	PC 495 ¹	Research Work – I Progress Evaluation**	-	-	6
Practical/ Viva Voce					
AEC	PC 481	* Summer Training (after 6 th Sem) Report	-	-	2
Total			-	-	22

Students are allowed to do academic research in this semester, if following this route for the award of the degree. The students allowed to proceed for this route shall be required to submit a report (ICT491). The report has to be countersigned by the mentor concerned. Marks out of 40 have to awarded by the mentor (on a performa to be provided by the school) and submitted confidentially to the school (this may be done through email). The same has to be countersigned by the mentor at the organization where internship is completed. The format of the report shall be specified by the school. The student shall continue on this route for completion of the requirements of the degree in the final semester. However, the APC of the school may allow change of route to the "Regular Route" in the eighth semester, but students changing their route from "Research Route" to "Regular Route", in the eight semester, shall not be eligible for award of minor specialization(s) minor specialization(s) and / or Honours.

*NUES: Evaluation by the committee of teachers, constituted by the Academic Programme Committee, out of 100 marks. This exam may be conducted online as the students may be placed outside the city for internship and may not be able to attend in the physical mode.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

B.Tech/M.Tech Dual Degree

Eighth Semester					
Group	Code	Paper	L	P	Credits
Regular Route					
Project	PC 402 ¹	Major Project – Report and Viva Voce	-	-	20
	PC 406 ¹	Major Project Progress Evaluation*	-	-	6
Internship Route					
Internship	PC 408 ¹	Internship Report – II	-	-	8
	PC 412 ¹	Internship Progress Evaluation*	-	-	4
Project	PC 414 ¹	Major Project – Report			10
	PC 418 ¹	Major Project Progress Evaluation*			6
Research Route					
Research	PC 420 ¹	Thesis** and Viva Voce	-	-	20
	PC 424 ¹	Research Work Progress Evaluation*	-	-	6
Total			-	-	26

Note: The student continues with the degree route as completed in the seventh semester. However, the APC of the school may allow changes within the scope of this document.

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

** Submission of the thesis is to be allowed only if a paper has been accepted / published in a Scopus /Web of Science indexed conference / journal.

In the absence of the supervisor, the Dean of the School can assign the responsibility of the supervisor to any faculty of the school.

¹The credits for these papers are mandatorily required to be earned by the student for the award of the degree through this route.

PROGRAMME CORE ELECTIVE PAPERS

Paper	Paper Code	Paper Name	T	P	Credits
Semester 5: Choose any one paper					
EPE331	EPE 331T	Internet of Things (IoT)	3	-	3
	EPE 331P	Internet of Things (IoT) Lab	-	2	1
EPE337	EPE 337T	VLSI Design and Technology	3	-	3
	EPE 337P	VLSI Design and Technology Lab	-	2	1
Semester 6: Choose any one paper					
EPE332	EPE 332T	Advanced Digital Signal Processing	3	-	3
	EPE 332P	Advanced Digital Signal Processing Lab	-	2	1
EPE338	EPE 338T	Embedded Systems Design	3	-	3
	EPE 338P	Embedded Systems Design Lab	-	2	1
EPE340	EPE 340T	Machine Learning for Signal Processing	3	-	3
	EPE 340P	Machine Learning for Signal Processing Lab	-	2	1
EPE336	EPE 336T	Radar and Satellite Communication	3	-	3
	EPE 336P	Radar and Satellite Communication Lab	-	2	1
EPE334	EPE 334T	Robotics and Automation	3	-	3
	EPE 334P	Robotics and Automation Lab	-	2	1
EPE341	EPE 342T	Information Theory and Coding	3	-	3
	EPE 342P	Information Theory and Coding Lab	-	2	1

MINOR SPECIALIZATION STREAMS

(Programme Core Elective Streams)

These papers / streams shall be offered as per the prerequisite specified. The papers are to be offered to at the undergraduate level to the students of Undergraduate part of the Dual Degree programme. A course/ paper is identified by the code allocated. A course may be split in to a theory component which shall have the letter 'T' attached while its practical component shall have the letter 'P' suffixed. A student has to study both the theory and the practical component, of a course, if taken as an elective.

Programme Core Area Elective Group: Minor Specialization in Embedded Systems and IoT

Prerequisite: Only to be offered to students of B.Tech./M.Tech.(Dual degree) in ECE (B.Tech.Part)

Code	PaperCode	Paper	L	P	Credits	Semester
PCE 361	PCE 361T	Internet of Things (IoT)	3	-	3	5th
	PCE 361P	Internet of Things (IoT) Lab	-	2	1	
PCE 304	PCE 304T	Embedded Systems Design	3	-	3	6th
	PCE 304P	Embedded Systems Design Lab	-	2	1	
PCE 326	PCE 326T	Real-Time Operating Systems	3	-	3	6th
	PCE 326P	Real-Time Operating Systems Lab	-	2	1	
PCE 451	PCE 451T	ARM Microcontrollers and Interfacing	3	-	3	7th
	PCE 451P	ARM Microcontrollers and Interfacing Lab	-	2	1	
PCE 453	PCE 453T	Edge AI and TinyML	3	-	3	
	PCE 453P	Edge AI and TinyML Lab	-	2	1	

Note: The students opting for this group cannot take the papers PE331, PE338 as Programme Electives, nor can they take Minor Specialization in Internet of Things or Minor Specialization in Automation and Robotics

MINOR SPECIALIZATION STREAMS (EMERGING AREA ELECTIVE GROUPS)

Emerging Area Elective Group: Minor Specialization in Artificial Intelligence

Code	PaperCode	Paper	L	P	Credits	Semester
EAE355	EAE 355T	Statistics and Statistical Modelling	3	-	3	5 th
	EAE 355P	Statistics and Statistical Modelling Lab	-	2	1	
EAE388	EAE 388T	Advanced Machine Learning	3	-	3	6 th
	EAE 388P	Advanced Machine Learning Lab	-	2	1	
EAE390	EAE 390T	Introduction to Data Analytics and Data Visualisation	3	-	3	6 th
	EAE 390P	Introduction to Data Analytics and Data Visualisation Lab	-	2	1	
EAE415	EAE 415T	Large Language Models and Generative AI	3	-	3	7 th
	EAE 415P	Large Language Models and Generative AI Lab	-	2	1	
EAE417	EAE 417T	Deep Learning and Reinforcement Learning	3	-	3	7 th
	EAE 417P	Deep Learning and Reinforcement Learning Lab	-	2	1	

Note: The students opting for this group cannot take the papers PE335, PE337, PE341, PE358 as Programme Electives

Emerging Area Elective Group: Minor Specialization in Data Science

Code	PaperCode	Paper	L	P	Credits	Semester
EAE 355	EAE 355T	Statistics and Statistical Modelling	3	-	3	5 th
	EAE 355P	Statistics and Statistical Modelling Lab	-	2	1	
EAE 388	EAE 388T	Advanced Machine Learning	3	-	3	6 th
	EAE 388P	Advanced Machine Learning Lab	-	2	1	
EAE 390	EAE 390T	Introduction to Data Analytics and Data Visualisation	3	-	3	6 th
	EAE 390P	Introduction to Data Analytics and Data Visualisation Lab	-	2	1	
EAE 419	EAE 419T	Data Warehousing and Business Intelligence	3	-	3	7 th
	EAE 419P	Data Warehousing and Business Intelligence Lab	-	2	1	
EAE 413	EAE 413T	Big Data Analytics	3	-	3	7 th
	EAE 413P	Big Data Analytics Lab	-	2	1	

Note: The students opting for this group cannot take the papers PE335, PE337, PE341, PE356, PE358 as Programme Electives

SYLLABI for

Bachelor of Technology / Master of Technology (Dual Degree Programmes)

Syllabus of 5th Semester for

- f. Computer Science and Engineering**
- g. Computer Science and Engineering – Artificial Intelligence**
- h. Computer Science and Engineering – Data Science**
- i. Information Technology**
- j. Electronics and Communications Engineering**

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At
GGSIP University, Dwarka Campus**

Applicable to the batch admitted in 2024-25 AS



**GURU GOBIND SINGH
INDRAPRASTHA
UNIVERSITY**

**Guru Gobind Singh Indraprastha University
Sector 16C, Dwarka, Delhi –110078[INDIA]**

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Note: Labs (if any) corresponding to the theory paper shall be inferred from the paper name.

Paper Code: PC 301	Paper: Technical and Scientific Writing	I	T/P	C
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Paper ID:		2	0	2								
Prerequisite Paper:												
Marking Scheme:												
1. Teacher's Continuous Evaluation: 100 marks												
Guidelines for Paper Setter(s):												
1. There should be 9 questions in the term end examinations question paper.												
2. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks.												
3. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five 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 objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Understand the principles and conventions of technical and scientific writing.											
CO 2	Apply appropriate structure and style in preparing technical documents.											
CO 3	Analyze and present scientific information clearly using visual and written formats.											
CO 4	Produce well-organized reports, research papers, and professional documents.											
Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	3	3	3	1	1
CO2	3	-	-	-	-	-	-	3	3	3	1	1
CO3	1	-	-	-	-	-	-	3	3	3	1	1
CO4	1	-	-	-	-	-	-	3	3	3	1	1

Unit 1

Introduction to technical and scientific writing, characteristics and importance, differences between general and technical writing, audience analysis and purpose, clarity, precision, and conciseness in writing, common grammatical and stylistic errors, tone and language in technical documents, ethics in technical writing, plagiarism and citation practices.

Unit 2

Types of technical documents: reports, manuals, research papers, proposals, structure of technical documents: title, abstract, introduction, methodology, results, discussion, conclusion, organizing content logically, paragraph development and coherence, use of headings, lists, and formatting styles, referencing styles (IEEE format), bibliography and citations.

Unit 3

Presenting data effectively: tables, graphs, charts, and diagrams, visual design principles, interpretation of data and results, writing summaries and abstracts, literature review techniques, paraphrasing and summarizing, preparing presentations (oral and poster), use of presentation tools, communication of complex technical ideas to varied audiences.

Unit-4

Writing research papers and technical reports, project documentation, writing proposals and grant applications (overview), technical correspondence: emails, memos, and letters, collaborative writing and peer review, editing and proofreading techniques, use of tools (LaTeX, reference managers – overview), publication process and peer-reviewed journals (overview), case studies and practice exercises.

Text Books

- [1] M. Alley, *The Craft of Scientific Writing*, 4th ed. New York, NY, USA: Springer, 2018.
- [2] G. D. Gopen and J. A. Swan, *The Science of Scientific Writing*. Durham, NC, USA: American Scientist, 1990.

Reference Books

- [1] W. Strunk Jr. and E. B. White, *The Elements of Style*, 4th ed. Boston, MA, USA: Pearson, 2000.
- [2] R. Day and B. Gastel, *How to Write and Publish a Scientific Paper*, 8th ed. Santa Barbara, CA, USA: Greenwood, 2016.
- [3] A. J. Silyn-Roberts, *Writing for Science and Engineering*, 2nd ed. Oxford, U.K.: Elsevier, 2012.
- [4] N. J. Higham, *Handbook of Writing for the Mathematical Sciences*, 2nd ed. Philadelphia, PA, USA: SIAM, 1998.
- [5] J. M. Williams and J. Bizup, *Style: Lessons in Clarity and Grace*, 12th ed. Boston, MA, USA: Pearson, 2016.

Paper Code: PC 303	Paper: Compiler Design	L	T/P	C								
Paper ID:		3	0	3								
Prerequisite Paper:												
Marking Scheme:												
1. Teacher’s Continuous Evaluation: 40 marks												
2. Term and Theory Examinations: 60 marks												
Guidelines for Paper Setter(s):												
1. There should be 9 questions in the term end examinations question paper.												
2. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks.												
3. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five 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 objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Understand the phases of a compiler and implement lexical analysis techniques.											
CO 2	Apply syntax analysis methods and construct parsers for programming languages.											
CO 3	Analyze semantic structures and generate intermediate code representations.											
CO 4	Design code optimization strategies and understand runtime environment management.											
Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	-	-	1	2	1
CO2	3	3	3	3	3	-	-	-	-	1	2	1
CO3	3	3	3	3	3	-	-	-	-	1	2	1
CO4	3	3	3	3	3	-	-	-	-	1	2	1

Unit 1

Introduction to compilers: structure of a compiler, phases of compilation, compiler construction tools. Lexical analysis: role of lexical analyzer, input buffering, specification of tokens, regular expressions, finite automata (DFA/NFA), lexical analyzer generators. Error handling in lexical analysis.

Unit 2

Role of parser, context-free grammars (CFG), derivations, parse trees. Top-down parsing: recursive descent parsing, predictive parsing, LL(1) grammars. Bottom-up parsing: shift-reduce parsing, LR parsing, SLR, CLR, and LALR parsers. Error recovery in syntax analysis.

Unit 3

Syntax-directed definitions and translation schemes. Type checking, symbol tables, semantic rules. Intermediate representations: syntax trees, DAGs, three-address code. Intermediate code generation for expressions, control flow, and procedures.

Unit-4

Code generation: issues in design, target machine, register allocation and assignment. Code optimization: machine-independent optimizations (constant folding, dead code elimination, common subexpression elimination). Machine-dependent optimizations. Runtime environment: storage organization, activation records, parameter passing.

Text Books

- [1] A. V. Aho, M. S. Lam, R. Sethi, and J. D. Ullman, Compilers: Principles, Techniques, and Tools, 2nd ed. Boston, MA, USA: Pearson, 2007.
- [2] K. D. Cooper and L. Torczon, Engineering a Compiler, 2nd ed. Burlington, MA, USA: Morgan Kaufmann, 2011.

Reference Books

- [1] D. M. Dhamdhere, Compiler Construction: Principles and Practice, 2nd ed. New Delhi, India: Macmillan India, 2008.
- [2] S. S. Muchnick, Advanced Compiler Design and Implementation. San Francisco, CA, USA: Morgan Kaufmann, 1997.
- [3] R. Mak, Writing Compilers and Interpreters: A Software Engineering Approach, 3rd ed. Hoboken, NJ, USA: Wiley, 2009.

- [4] K. C. Loudon, Compiler Construction: Principles and Practice. Boston, MA, USA: Cengage Learning, 1997.
- [5] J. R. Levine, T. Mason, and D. Brown, Lex & Yacc, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 1992..

Paper Code: PC 305	Paper: Programming in C++				L	P	C					
Paper ID:					3	0	3					
Prerequisite Papers: None												
Marking Scheme : 1. Teacher’s Continuous Evaluation : 40 marks 2. Term and 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 questions of total 12 marks. 3. Apart from question one which is compulsory, rest of the paper shall consists of four 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 up to 5 sub-parts/sub-questions. Each unit shall have a marks weightage of 12. 4. The questions are to be framed keeping in view the learning objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
Course Objectives : 1. To introduce the basic Concepts of Object Oriented Programming (data types, operators and functions) using C++ 2. To introduce concepts of Classes and Objects with the examples of C++ programming 3. To understand object oriented features such as Inheritance and Polymorphism 4. To use various object oriented concepts (exceptional handling) to solve different problems												
Course Outcomes (CO) CO 1 Ability to have an in-depth knowledge of object oriented programming paradigm CO 2 To be able to develop basic C++ programming skills CO 3 To be able to apply various object oriented features using C++ CO 4 Ability to have an understanding of generic programming & standard templates												
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	1	-	-	2	-	-	-	-	-	-	1
CO 2	3	2	2	1	3	-	-	-	-	-	-	1
CO 3	3	3	2	1	3	-	-	-	-	-	-	1
CO 4	3	2	2	1	2	-	-	-	-	-	-	1

Unit I

Object Oriented Programming Paradigm, Basic Concepts of Object Oriented Programming, Benefits of Object Oriented Programming, Object Oriented Languages, Applications of Object Oriented Programming, C++ Programming Language, Tokens, Keywords, Identifiers and Constants, Data Types, Type Compatibility, Variables, Operators in C++, Implicit Type Conversions, Operator Precedence, The Main Function, Function Prototyping, Call by Reference, Return by Reference, Inline Functions, Function Overloading, Friend Functions, default parameter value.

UNIT - II

Specifying a class, Member Functions, Encapsulation, information hiding, abstract data types, objects & classes, Static Member Functions, Arrays of Objects, Constructors & Destructors, Parameterized Constructors, Copy Constructors, Dynamic Constructors, Destructors, identity and behaviour of an object, C++ garbage collection, dynamic memory allocation, Explicit Type Conversions, Operator Overloading.

UNIT - III

Inheritance, inheritance methods, Class hierarchy, derivation – public, private & protected, aggregation, Inheritance Constructors, composition vs. classification hierarchies, Containership, Initialization List, Polymorphism, categorization of polymorphic techniques, polymorphism by parameter, parametric polymorphism, generic function – template function, function overriding, run time polymorphism, virtual functions.

UNIT – IV

Standard C++ classes, using multiple inheritance, persistent objects, streams and files, namespaces, exception handling, generic classes, standard template library: Library organization and containers, standard containers, algorithm and Function objects, iterators and allocators, strings, streams, manipulators, user defined

manipulators, vectors.

Textbook(s):

1. Stanley B. Lippman, Josée Lajoie, Barbara E. Moo, "C++ Primer", Addison-Wesley Professional, 2012.
2. Ivor Horton, "Using the C++ Standard Template Libraries", Apress, 2015.
3. R. Lafore, "Object Oriented Programming using C++", SAMS, 4th Ed. 2008.

References:

1. A.R.Venugopal, Rajkumar, T. Ravishanker "Mastering C++", TMH, 2013
2. Bjarne Stroustrup, "Programming: principles and practice using C++", Addison-Wesley, Latest Ed.
3. Bjarne Stroustrup, "A Tour of C++", Addison-Wesley Professional, Latest Ed.
4. Bjarne Stroustrup, "The C++ Programming Language", 4th Edition, Addison-Wesley Professional, 2013.
5. Peter Van Weert and Marc Gregoire, "C++17 Standard Library Quick Reference: A Pocket Guide to Data Structures, Algorithms, and Functions", Apress (2019)
6. E. Balaguruswamy, "Objected Oriented Programming with C++", TMH, 2026
7. Steven C. Lawlor, "The Art of Programming Computer Science with C++", PWS, 1997.
8. Slobodan Dimitrović, "Modern C++ for Absolute Beginners": A Friendly Introduction to C++ Programming Language and C++11 to C++20 Standards", Apress, 2020

Paper Code: PE 331T	Paper: Digital Signal Processing	L	T/P	C								
Paper ID:		3	0	3								
Prerequisite Paper:												
Marking Scheme:												
1. Teacher's Continuous Evaluation: 40 marks												
2. Term and Theory Examinations: 60 marks												
Guidelines for Paper Setter(s):												
1. There should be 9 questions in the term end examinations question paper.												
2. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks.												
3. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five 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 objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Understand discrete-time signals and systems and analyze their properties.											
CO 2	Apply transform techniques such as Z-transform and DFT for signal analysis.											
CO 3	Design and analyze digital filters using standard techniques.											
CO 4	Implement DSP algorithms and understand their practical applications.											
Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	2	2	3	-	-	-	3	2	2	3
CO2	3	2	2	2	3	-	-	-	3	2	2	3
CO3	3	2	2	2	3	-	-	-	3	2	2	3
CO4	3	2	2	2	3	-	-	-	3	2	2	3

Unit 1

Introduction to signals and systems: classification of signals (continuous-time vs discrete-time, periodic vs aperiodic, deterministic vs random). Basic discrete-time signals: unit impulse, unit step, exponential, sinusoidal sequences. Operations on signals: time shifting, scaling, folding. Discrete-time systems: classification (linear, time-invariant, causal, stable). Convolution sum: graphical and analytical methods, properties of convolution. Difference equations: representation of discrete-time systems using linear constant coefficient difference equations. System properties: stability (BIBO), causality, invertibility.

Unit 2

Z-transform: definition, region of convergence (ROC), properties of Z-transform. Inverse Z-transform: partial fraction expansion, power series method. Analysis of LTI systems using Z-transform: system function, poles and zeros, stability analysis. Frequency response of discrete-time systems. Discrete Fourier Transform (DFT): definition, properties, circular convolution. Fast Fourier Transform (FFT): radix-2 algorithm, decimation-in-time (DIT) and decimation-in-frequency (DIF) techniques.

Unit 3

Introduction to digital filters: classification (FIR and IIR filters). FIR filter design: windowing techniques (rectangular, Hamming, Hanning, Blackman), frequency sampling method. IIR filter design: analog filter approximation (Butterworth, Chebyshev), bilinear transformation, impulse invariance method. Realization structures for digital filters: direct form, cascade form, parallel form. Comparison between FIR and IIR filters.

Unit-4

Multirate signal processing: decimation and interpolation. Sampling theorem and aliasing. Quantization effects: finite word length effects, round-off noise, overflow. DSP processors and architectures. Applications: speech processing, image processing, biomedical signal processing, communication systems.

Text Books

- [1] A. V. Oppenheim and R. W. Schaffer, Discrete-Time Signal Processing, 3rd ed. Upper Saddle River, NJ, USA: Pearson, 2010.
- [2] J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, 4th ed. Upper Saddle River, NJ, USA: Pearson, 2007.

Reference Books

- [1] S. K. Mitra, Digital Signal Processing: A Computer-Based Approach, 4th ed. New York, NY, USA: McGraw-Hill, 2011.

- [2] E. C. Ifeachor and B. W. Jervis, Digital Signal Processing: A Practical Approach, 2nd ed. Harlow, U.K.: Pearson, 2002.
- [3] R. Lyons, Understanding Digital Signal Processing, 3rd ed. Upper Saddle River, NJ, USA: Pearson, 2011.
- [4] A. Antoniou, Digital Signal Processing: Signals, Systems, and Filters. New York, NY, USA: McGraw-Hill, 2005.
- [5] B. P. Lathi, Signal Processing and Linear Systems. Berkeley, CA, USA: Oxford University Press, 2005.

Paper Code: PE 333T / PE 357T	Paper: Natural Language Processing	L	T/P	C								
Paper ID:		3	0	3								
Prerequisite Paper:												
Marking Scheme:												
1. Teacher's Continuous Evaluation: 40 marks												
2. Term and Theory Examinations: 60 marks												
Guidelines for Paper Setter(s):												
1. There should be 9 questions in the term end examinations question paper.												
2. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks.												
3. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five 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 objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Understand fundamental concepts of natural language processing and text preprocessing techniques.											
CO 2	Apply syntactic and semantic analysis methods for processing natural language.											
CO 3	Analyze statistical and machine learning approaches used in NLP tasks.											
CO 4	Design NLP applications using modern techniques such as deep learning and transformers.											
Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	-	-	2	-	-	-	-	-	-	1
CO2	3	3	1	1	2	-	-	-	-	-	-	1
CO3	3	3	2	2	2	-	-	-	-	-	-	1
CO4	3	3	3	2	3	-	-	-	-	-	-	2

Unit 1

Introduction to Natural Language Processing: scope, challenges, and applications. Levels of language processing: morphological, lexical, syntactic, semantic, discourse. Text preprocessing: tokenization, normalization, stemming, lemmatization, stop-word removal. Regular expressions, corpus and corpus linguistics, introduction to language models (n-grams).

Unit 2

Part-of-speech tagging: rule-based, stochastic approaches. Syntactic parsing: context-free grammars (CFG), constituency and dependency parsing. Semantic analysis: word sense disambiguation, semantic roles, lexical semantics. Introduction to discourse processing..

Unit 3

Probabilistic models: n-gram language models, smoothing techniques. Hidden Markov Models (HMM), Conditional Random Fields (CRF). Text classification: Naïve Bayes, Support Vector Machines (SVM). Named Entity Recognition (NER), information extraction..

Unit-4

Word embeddings: Word2Vec, GloVe, FastText. Neural networks for NLP: RNN, LSTM, GRU. Transformers and attention mechanisms. Applications: machine translation, sentiment analysis, question answering, chatbots.

Text Books

- [1] J. Eisenstein, Introduction to Natural Language Processing. Cambridge, MA, USA: MIT Press, 2019.
- [2] S. Bird, E. Klein, and E. Loper, Natural Language Processing with Python. Sebastopol, CA, USA: O'Reilly Media, 2009.

Reference Books

- [1] Y. Goldberg, Neural Network Methods for Natural Language Processing. San Rafael, CA, USA: Morgan & Claypool, 2017.
- [2] D. Sarkar, Text Analytics with Python: A Practitioner's Guide to Natural Language Processing. Berkeley, CA, USA: Apress, 2016.
- [3] T. Mikolov et al., "Efficient estimation of word representations in vector space," in Proc. ICLR, 2013.
- [4] A. Vaswani et al., "Attention is all you need," in Proc. NeurIPS, 2017.
- [5] J. Devlin et al., "BERT: Pre-training of deep bidirectional transformers for language understanding," in Proc. NAACL-HLT, 2019.

Paper Code: PCE 349T	Paper Advanced Software Architecture and System Design	L	T/P	C								
Paper ID:		3	0	3								
Prerequisite Paper:												
Marking Scheme:												
1. Teacher's Continuous Evaluation: 40 marks												
2. Term and Theory Examinations: 60 marks												
Guidelines for Paper Setter(s):												
1. There should be 9 questions in the term end examinations question paper.												
2. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks.												
3. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five 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 objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Analyze and evaluate software architecture patterns for large-scale systems.											
CO 2	Design scalable, reliable, and maintainable software architectures.											
CO 3	Apply architectural principles for distributed and cloud-based systems											
CO 4	Assess trade-offs in system design considering performance, security, and scalability.											
Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	2	2	2	-	-	-	-	1	1	2
CO2	3	3	3	2	3	-	-	-	1	1	2	2
CO3	3	3	3	3	3	1	-	-	1	1	2	2
CO4	3	3	3	3	3	1	1	1	1	2	2	3

Unit 1

Introduction to advanced software architecture, role of software architect, architectural thinking and decision-making, quality attributes: scalability, performance, availability, maintainability, reliability, modifiability, architectural views and viewpoints (logical, development, process, physical views), architectural styles and patterns: layered architecture, client-server, event-driven architecture, microservices vs monolithic architecture, service-oriented architecture (SOA), architectural documentation and evaluation techniques (ATAM overview).

Unit 2

System design fundamentals, requirements to architecture mapping, high-level system design, scalability concepts: vertical vs horizontal scaling, load balancing strategies, caching techniques, database design for scale (SQL vs NoSQL), CAP theorem, consistency models, distributed system design considerations, fault tolerance and high availability, replication and partitioning strategies, API design principles (RESTful services), rate limiting and throttling.

Unit 3

Design of distributed systems, inter-service communication: synchronous vs asynchronous communication, message queues and event streaming, microservices architecture: decomposition strategies, service discovery, API gateways, containerization and orchestration (Docker, Kubernetes overview), cloud-native design principles, resilience patterns: circuit breaker, bulkhead, retry mechanisms, observability: logging, monitoring, tracing, DevOps integration with architecture..

Unit-4

Security in system design: authentication, authorization, secure API design, data protection, system performance optimization techniques, trade-off analysis and decision-making, design for large-scale systems (social networks, e-commerce, streaming systems), system design case studies and interview-oriented problems (URL shortener, messaging system, distributed file system), emerging trends: serverless architecture, edge computing, AI-driven system design, best practices and anti-patterns in software architecture.

Text Books

[1] L. Bass, P. Clements, and R. Kazman, *Software Architecture in Practice*, 4th ed. Boston, MA, USA: Addison-Wesley, 2021.

[2] M. Richards and N. Ford, *Fundamentals of Software Architecture: An Engineering Approach*. Sebastopol, CA, USA: O'Reilly Media, 2020.

Reference Books

- [1] M. Kleppmann, *Designing Data-Intensive Applications*. Sebastopol, CA, USA: O'Reilly Media, 2017.
- [2] S. Newman, *Building Microservices*, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 2021.
- [3] G. Hohpe and B. Woolf, *Enterprise Integration Patterns*. Boston, MA, USA: Addison-Wesley, 2008.
- [4] E. Evans, *Domain-Driven Design*. Boston, MA, USA: Addison-Wesley, 2003.
- [5] B. Burns et al., *Kubernetes: Up and Running*, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2022.

Paper Code: PE 341T / PCE 355T / PC307	Paper: Statistics and Statistical Modelling	L	T/P	C								
Paper ID:		3	0	3								
Prerequisite Paper:												
Marking Scheme:												
1. Teacher's Continuous Evaluation: 40 marks												
2. Term and Theory Examinations: 60 marks												
Guidelines for Paper Setter(s):												
1. There should be 9 questions in the term end examinations question paper.												
2. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks.												
3. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five 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 objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Understand fundamental statistical concepts and summarize data using descriptive measures.											
CO 2	Apply probability theory and standard distributions to model uncertainty.											
CO 3	Perform statistical inference using estimation and hypothesis testing techniques.											
CO 4	Develop and evaluate statistical models for data analysis and prediction.											
Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	2	2	2	-	-	-	-	1	1	2
CO2	3	3	3	2	3	-	-	-	-	1	1	2
CO3	3	3	3	3	3	-	-	-	-	1	1	2
CO4	3	3	3	3	3	-	-	-	-	2	1	3

Unit 1

Introduction to statistics: types of data (nominal, ordinal, interval, ratio) and data sources. Data collection and sampling techniques. Data presentation: tables, frequency distributions, histograms, box plots. Measures of central tendency: mean, median, mode. Measures of dispersion: range, variance, standard deviation, coefficient of variation. Moments, skewness, and kurtosis. Exploratory Data Analysis (EDA) and data visualization basics.

Unit 2

Basics of probability: sample space, events, conditional probability, Bayes' theorem. Random variables: discrete and continuous. Probability mass function (PMF) and probability density function (PDF). Mathematical expectation, variance, and moments. Standard distributions: Binomial, Poisson, Normal distributions. Joint distributions, marginal and conditional distributions. Central Limit Theorem and its significance.

Unit 3

Sampling distributions and standard error. Estimation theory: point estimation and interval estimation. Confidence intervals for mean and proportion. Hypothesis testing: null and alternative hypotheses, Type I and Type II errors, p-values. Parametric tests: z-test, t-test, chi-square test, F-test (ANOVA). Non-parametric tests (overview). Goodness-of-fit tests.

Unit-4

Correlation analysis: Pearson and Spearman correlation. Regression analysis: simple and multiple linear regression, assumptions, model fitting. Model diagnostics: residual analysis, multicollinearity, goodness-of-fit (R^2 , adjusted R^2). Introduction to generalized linear models (overview). Time series basics: components (trend, seasonality), simple forecasting methods. Introduction to stochastic processes (overview). Applications in engineering, business analytics, and data science.

Text Books

- [1] D. C. Montgomery and G. C. Runger, *Applied Statistics and Probability for Engineers*, 7th ed. Hoboken, NJ, USA: Wiley, 2018.
- [2] G. Casella and R. L. Berger, *Statistical Inference*, 2nd ed. Pacific Grove, CRC Press, 2024.

Reference Books

- [1] J. L. Devore, *Probability and Statistics for Engineering and the Sciences*, 9th ed. Boston, MA, USA: Cengage Learning, 2015.
- [2] A. M. Mood, F. A. Graybill, and D. C. Boes, *Introduction to the Theory of Statistics*, 3rd ed. New York, NY, USA:

McGraw-Hill, 1974.

[3] T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning*, 2nd ed. New York, NY, USA: Springer, 2009.

[4] W. Mendenhall, R. J. Beaver, and B. M. Beaver, *Introduction to Probability and Statistics*, 14th ed. Boston, MA, USA: Cengage Learning, 2020.

[5] P. J. Brockwell and R. A. Davis, *Introduction to Time Series and Forecasting*, 2nd ed. New York, NY, USA: Springer, 2016.

Paper Code: PE 368T / PCE 361T / PE366T / OAE361T	Paper: Introduction to IoT	L	T/P	C								
Paper ID:		3	0	3								
Prerequisite Paper:												
Marking Scheme: 1. Teacher’s Continuous Evaluation: 40 marks 2. Term and Theory Examinations: 60 marks												
Guidelines for Paper Setter(s): 1. There should be 9 questions in the term end examinations question paper. 2. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks. 3. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five 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 objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book. 5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Understand the fundamental concepts, architecture, and components of IoT systems.											
CO 2	Analyze communication protocols and networking technologies used in IoT.											
CO 3	Design IoT-based applications using sensors, devices, and cloud platforms.											
CO 4	Evaluate security, privacy, and real-world challenges in IoT deployments.											
Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	-	-	1	-	-	-	-	-	-	1
CO2	3	3	1	1	3	-	-	-	-	-	-	1
CO3	3	3	3	2	3	1	-	-	-	-	-	1
CO4	3	3	2	3	2	2	1	2	-	-	-	2

Unit 1

Introduction to Internet of Things: definition, characteristics, and evolution, IoT vs traditional embedded systems, IoT ecosystem and components, IoT architecture: perception, network, and application layers, physical design of IoT: sensors, actuators, and devices, logical design of IoT systems, identification technologies: RFID, NFC, overview of IoT enabling technologies, applications of IoT in smart homes, healthcare, agriculture, and smart cities.

Unit 2

IoT communication models: request-response, publish-subscribe, push-pull, exclusive pair, networking basics for IoT, protocols: MQTT, CoAP, HTTP, WebSockets, wireless communication technologies: Wi-Fi, Bluetooth, Zigbee, LoRaWAN, cellular IoT, addressing and identification: IPv6, 6LoWPAN, edge and fog computing concepts, gateways and middleware in IoT systems.

Unit 3

IoT hardware platforms: Arduino, Raspberry Pi (overview), interfacing sensors and actuators, data acquisition and preprocessing, cloud platforms for IoT (AWS IoT, Azure IoT – overview), data storage and analytics in IoT, real-time data processing, application development frameworks for IoT, APIs and integration, visualization dashboards, case studies of IoT application development.

Unit-4

Security challenges in IoT: threats, vulnerabilities, and attack vectors, authentication and authorization mechanisms, data encryption and secure communication, privacy issues in IoT systems, device management and firmware updates, scalability and interoperability challenges, energy efficiency and power management, industrial IoT (IIoT), smart cities and smart grid applications, ethical and regulatory issues, future trends in IoT.

Text Books

- [1] A. Bahga and V. Madisetti, *Internet of Things: A Hands-On Approach*. Blacksburg, VA, USA: VPT, 2015.
- [2] S. Madakam, R. Ramaswamy, and S. Tripathi, *Internet of Things (IoT): A Practical Approach*. New Delhi, India: McGraw-Hill Education, 2018.

Reference Books

- [1] V. K. Jain, *Internet of Things*. New Delhi, India: Khanna Publishing House, 2017.
- [2] O. Hersent, D. Boswarthick, and O. Elloumi, *The Internet of Things: Key Applications and Protocols*, 2nd ed. Hoboken, NJ, USA: Wiley, 2012.

- [3] D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, and J. Henry, *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things*. Indianapolis, IN, USA: Cisco Press, 2017.
- [4] A. McEwen and H. Cassimally, *Designing the Internet of Things*. Chichester, U.K.: Wiley, 2014.
- [5] S. Li, L. Da Xu, and S. Zhao, "The Internet of Things: A survey," *Inf. Syst. Front.*, vol. 17, no. 2, pp. 243–259, 2015.

Paper Code: PCE 388T /PC309/EAE388	Paper: Advanced Machine Learning	L	T/P	C								
Paper ID:		3	0	3								
Prerequisite Paper:												
Marking Scheme:												
1. Teacher's Continuous Evaluation: 40 marks												
2. Term and Theory Examinations: 60 marks												
Guidelines for Paper Setter(s):												
1. There should be 9 questions in the term end examinations question paper.												
2. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks.												
3. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five 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 objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Analyze advanced machine learning models and their theoretical foundations.											
CO 2	Apply ensemble and probabilistic learning techniques to complex datasets.											
CO 3	Evaluate model performance using advanced validation and optimization strategies.											
CO 4	Design robust machine learning solutions for real-world problems.											
Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	2	2	2	-	-	-	-	-	-	1
CO2	3	3	3	2	3	-	-	-	-	-	-	1
CO3	3	3	3	3	3	-	-	-	-	-	-	2
CO4	3	3	3	3	3	-	-	-	-	-	-	1

Unit 1

Review of machine learning fundamentals, bias-variance tradeoff, overfitting and underfitting, regularization techniques (L1, L2, Elastic Net), cross-validation methods, model selection strategies, hyperparameter tuning (grid search, random search), performance metrics for classification and regression, ROC curves, precision-recall tradeoffs, handling imbalanced datasets, introduction to statistical learning theory and generalization.

Unit 2

Introduction to ensemble learning, bagging and bootstrap aggregation, random forests and feature importance, boosting techniques: AdaBoost, Gradient Boosting, XGBoost (conceptual), stacking and blending methods, bias-variance reduction using ensembles, practical considerations in ensemble model design, comparison of ensemble techniques and applications.

Unit 3

Probabilistic machine learning framework, Bayesian inference and Bayes theorem, prior and posterior distributions, maximum likelihood vs maximum a posteriori estimation, Gaussian mixture models, Expectation-Maximization (EM) algorithm, variational inference (overview), probabilistic graphical models (Bayesian networks overview), uncertainty estimation in machine learning models.

Unit-4

Support Vector Machines (advanced concepts): kernels, soft margins, optimization intuition, anomaly detection techniques, semi-supervised and active learning (advanced perspective), model interpretability and explainable AI (SHAP, LIME – overview), fairness and bias in machine learning, deployment considerations and model lifecycle, case studies in real-world machine learning applications.

Text Books

- [1] K. P. Murphy, *Machine Learning: A Probabilistic Perspective*. Cambridge, MA, USA: MIT Press, 2022.
- [2] T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning*, 2nd ed. New York, NY, USA: Springer, 2009.

Reference Books

- [1] C. M. Bishop, *Pattern Recognition and Machine Learning*. New York, NY, USA: Springer, 2006.
- [2] E. Alpaydin, *Introduction to Machine Learning*, 4th ed. Cambridge, MA, USA: MIT Press, 2020.
- [3] A. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 2022.

- [4] K. P. Murphy, *Probabilistic Machine Learning: An Introduction*. Cambridge, MA, USA: MIT Press, 2022.
- [5] L. Breiman, "Random forests," *Mach. Learn.*, vol. 45, no. 1, pp. 5–32, 2001.

Paper Code: EPC303	Paper: Digital Signal Processing	L	T/P	C								
Paper ID:		3	0	3								
Prerequisite Paper:												
Marking Scheme:												
1. Teacher's Continuous Evaluation: 40 marks												
2. Term and Theory Examinations: 60 marks												
Guidelines for Paper Setter(s):												
1. There should be 9 questions in the term end examinations question paper.												
2. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks.												
3. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five 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 objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Understand discrete-time signals and systems and analyze their properties.											
CO 2	Apply transform techniques such as Z-transform and DFT for signal analysis.											
CO 3	Design and analyze digital filters using standard techniques.											
CO 4	Implement DSP algorithms and understand their practical applications.											
Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	2	2	3	-	-	-	3	2	2	3
CO2	3	2	2	2	3	-	-	-	3	2	2	3
CO3	3	2	2	2	3	-	-	-	3	2	2	3
CO4	3	2	2	2	3	-	-	-	3	2	2	3

Unit 1

Introduction: Signals, systems and signal processing, classification of signals, elements of digital signal processing system, concept of frequency in continuous and discrete time signals, Periodic Sampling, Frequency domain representation of sampling, Reconstructions of band limited signals from its samples. Review of Fourier and Laplace Transform.

Discrete-Time Signals and Systems (Frequency Domain analysis): Z-transform & Inverse Z-transform, Linear convolution and its properties, Linear Constant Coefficient Difference equations, Frequency domain representation of Discrete-Time Signals & Systems, Representation of sequences by discrete time Fourier Transform, (DTFT), Properties of discrete time Fourier Transform, and correlation of signals, Fourier Transform Theorems.

Unit 2

Analysis of Linear Time Invariant System: Analysis of LTI systems in time domain and stability considerations. Frequency response of LTI system, System functions for systems with linear constant-coefficient Difference equations, Freq. response of rational system functions relationship between magnitude & phase, All pass systems, inverse systems, Minimum/Maximum phase systems, systems with linear phase.

Unit 3

Structures for Discrete Time Systems: Block Diagram and signal flow diagram representations of Linear Constant Coefficient Difference equations, Basic Structures of IIR Systems, lattice and lattice-ladder structures, Transposed forms, Direct and cascade form Structures for FIR Systems, Linear Phase FIR structure, Effects of Coefficient quantization.

Filter Design Techniques: Design of Discrete-Time IIR filters from Continuous-Time filters Approximation b derivatives, Impulse invariance and Bilinear Transformation methods; Design of FIR filters by windowing techniques.

Unit-4

Discrete-Fourier Transform & Fast Fourier Transform: Representation of periodic sequences: The Discrete Fourier series and its properties Fourier transform of periodic signals. Sampling the fourier transform. The

district Fourier transform, properties of DFT, Linear Convolution using DFT. FFT- Efficient Computation of DFT, Goertzel Algorithm, radix2 Decimation-in-time and Decimation in Frequency FFT Algorithms

Text Books

1. Proakis, J.G. and Manolakis, D.G., Digital Signal Processing, Prentice Hall of India Private Limited.
2. A.V. Oppenheim, R.W. Schaffer, Digital Signal Processing, Pearson Education , 2010

Reference Books

- [1] S. K. Mitra, Digital Signal Processing: A Computer-Based Approach, 4th ed. New York, NY, USA: McGraw-Hill, 2011.
- [2]. A. V. Oppenheim, R.W. Schaffer and J.R. Buck, —Discrete-Time Signal Processing”, Pearson, 2004
- [3] E. C. Ifeachor and B. W. Jervis, Digital Signal Processing: A Practical Approach, 2nd ed. Harlow, U.K.: Pearson, 2002.
- [4] R. Lyons, Understanding Digital Signal Processing, 3rd ed. Upper Saddle River, NJ, USA: Pearson, 2011.
- [5] A. Antoniou, Digital Signal Processing: Signals, Systems, and Filters. New York, NY, USA: McGraw-Hill, 2005.
- [6] B. P. Lathi, Signal Processing and Linear Systems. Berkeley, CA, USA: Oxford University Press, 2005.

Paper Code: EPC305	Paper: Microprocessors and Interfacing	L	T/P	C								
Paper ID:		3	0	3								
Prerequisite Paper:												
Marking Scheme:												
3. Teacher's Continuous Evaluation: 40 marks												
4. Term and Theory Examinations: 60 marks												
Guidelines for Paper Setter(s):												
6. There should be 9 questions in the term end examinations question paper.												
7. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks.												
8. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five sub-parts/sub-questions. Each unit shall have a marks weightage of 10.												
9. The questions are to be framed keeping in view the learning objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
10. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Analyze the internal architecture, bus organization, and instruction execution cycles of 8-bit (8085) and 16-bit (8086) microprocessors.											
CO 2	Develop efficient assembly language programs for 8085 and 8086 microprocessors using modular programming techniques, interrupts, and system calls.											
CO 3	Design memory and I/O interfacing circuits using programmable peripheral chips for real-world signal acquisition and control systems.											
CO 4	Evaluate advanced microprocessor architectures, bus standards, and multi-core processing frameworks to solve complex engineering interfacing problems.											
Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	2	2	3	-	-	-	3	2	2	3
CO2	3	2	2	2	3	-	-	-	3	2	2	3
CO3	3	2	2	2	3	-	-	-	3	2	2	3
CO4	3	2	2	2	3	-	-	-	3	2	2	3

Unit 1

Introduction to microprocessor-based systems and evolution of microprocessors. Architecture of the 8085 microprocessor, functional block diagram, register organization, ALU, timing and control unit, and flag register. Bus structure: address bus, data bus, and control bus multiplexing. Instruction cycle, machine cycles, fetch and execute operations, and timing diagrams for memory read, memory write, I/O read, and I/O write operations. 8085 instruction set classification: data transfer, arithmetic, logical, branching, and machine control instructions. Addressing modes of 8085. Assembly language programming principles, stacks, subroutines, parameter passing, and delay loops. Interrupt structure of 8085: hardware and software interrupts, interrupt vectors, priority, and interrupt service routines (ISRs).

Unit 2

Architecture of the 8086 16-bit microprocessor: Bus Interface Unit (BIU) and Execution Unit (EU), pipeline architecture, and register organization. Memory segmentation, segment registers, logical and physical address generation, and memory organization in even and odd banks. Minimum and maximum mode configurations, pin functions, clock generation, reset, and bus timing diagrams. Addressing modes of 8086. Instruction set of 8086: data transfer, arithmetic, bit manipulation, string manipulation, control transfer, and processor control instructions. Assembler directives, operators, and assembly language programming (ALP) involving data conversions, array operations, and string processing. 8086 interrupt organization: interrupt vector table (IVT), hardware and software interrupts, dedicated interrupts, and custom interrupt handling.

Unit 3

Basic I/O interfacing concepts: memory-mapped I/O versus I/O-mapped I/O scheme. Interfacing static RAM and EPROM/Flash memories to 8086. Programmable Peripheral Interface (PPI - 8255): functional architecture, operating modes (Mode 0, Mode 1, and Mode 2), BSR mode, and interfacing matrix keypads, 7-segment displays, and stepper motors. Programmable Interval Timer/Counter (8254): internal block diagram, operating modes, and applications in square-wave generation and pulse measurement. Programmable Interrupt Controller (8259A): architecture, cascading, priority modes, and initialization command words (ICWs). Direct Memory Access (DMA) controller (8237/8257): concepts of DMA, bus request/grant cycles, architecture, and interfacing for high-speed

data transfer. Interfacing of Analog-to-Digital Converters (ADC 0808/0809) and Digital-to-Analog Converters (DAC 0800) with microprocessors.

Unit-4

Serial data communication principles: synchronous versus asynchronous transmission, baud rate, parity, and modem control signals. Programmable Communication Interface (USART - 8251A): architecture, control words, status register, and interfacing. Standard communication protocols and bus standards: RS-232C interface standard, USB, SPI, I2C, and PCI bus architecture. Overview of x86 architecture evolution: 80286 real and protected modes, 80386/80486 virtual memory management, paging mechanisms, and cache memory hierarchy. Introduction to Pentium processors, superscalar execution, speculative execution, branch prediction, and multi-core processing architectures. RISC versus CISC design philosophies, ARM architecture overview, and microprocessor-based system design case studies for real-time monitoring and control.

Text Books

- [1] R. S. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, 6th ed. Mumbai, India: Penram International Publishing, 2013.
- [2] A. K. Ray and K. M. Bhurchandi, Advanced Microprocessors and Peripherals: Architecture, Programming and Interfacing, 3rd ed. New Delhi, India: McGraw Hill Education, 2012.

Reference Books

- [3] B. B. Brey, The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4, and Core2 with 64-bit Extensions, 8th ed. Upper Saddle River, NJ, USA: Pearson Prentice Hall, 2009.
- [4] D. V. Hall, Microprocessors and Interfacing: Programming and Hardware, 2nd ed. New Delhi, India: Tata McGraw-Hill, 2006.
- [5] K. J. Ayala, The 8086 Microprocessor: Programming and Interfacing the PC, 1st ed. Cengage Learning, 2007.

Paper Code: PCE361T/EPE331T	Paper: Internet of Things (IoT)					L	T/P	C				
Paper ID:						3	0	3				
Prerequisite Paper:												
Marking Scheme:												
5. Teacher's Continuous Evaluation: 40 marks												
6. Term and Theory Examinations: 60 marks												
Guidelines for Paper Setter(s):												
11. There should be 9 questions in the term end examinations question paper.												
12. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks.												
13. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five sub-parts/sub-questions. Each unit shall have a marks weightage of 10.												
14. The questions are to be framed keeping in view the learning objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
15. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Understand the fundamental principles of the Internet of Things and its applications in engineering.											
CO 2	Describe and analyze the key technologies and protocols used in IoT systems											
CO 3	Design and develop simple IoT systems, integrating hardware and software components.											
CO 4	Evaluate the challenges and considerations related to security, privacy, and ethical aspects of IoT deployments											
Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	2	2	3	-	-	-	3	2	2	3
CO2	3	2	2	2	3	-	-	-	3	2	2	3
CO3	3	2	2	2	3	-	-	-	3	2	2	3
CO4	3	2	2	2	3	-	-	-	3	2	2	3

UNIT I

Introduction to Internet of Things (IoT): Definition and significance of IoT, Evolution of IoT, Components of IoT ecosystem, IoT applications in various engineering domains.

UNIT II

IoT Technologies and Protocols: Wireless communication technologies (Wi-Fi, Bluetooth, Zigbee, LoRa, NB-IoT), IoT protocols (MQTT, CoAP, HTTP), Sensor technologies, Actuators and control mechanisms.

UNIT III

IoT System Design and Implementation: Sensor-node architecture, Data acquisition and preprocessing, Cloud computing and edge computing for IoT, Data storage and management, Introduction to IoT platforms.

UNIT IV

IoT Security, Privacy, and Ethical Considerations: Security challenges in IoT, Authentication and encryption, Privacy concerns and data protection, Legal and ethical considerations in IoT deployments.

Textbooks:

1. B. Ray, "Internet of Things: A Hands-On Approach," Springer, 2020.
2. A. Dunkels, "Interconnecting Smart Objects with IP: The Next Internet," Morgan Kaufmann, 2010.

References:

1. T. Ahmed, "Internet of Things (IoT): A Comprehensive Introduction," Springer, 2019.
2. R. Roman, et al., "Key Management for the Internet of Things," IEEE Access, 2017.
3. R. Sheltami, et al., "Towards an IoT Cloud for Smart Cities: Experiences and Lessons," IEEE Internet of Things Journal, 2016.
4. J. Whitmore, et al., "Internet of Things: A survey of topics and trends," Information Systems Frontiers, 2015.

Paper Code: EPE337T	Paper: VLSI Design and Technology	L	T/P	C								
Paper ID:		3	-	3								
Prerequisite Paper: Semiconductor Engineering and Digital Electronics												
Marking Scheme:												
1. Teacher's Continuous Evaluation: 40 Marks												
2. Term End Theory Examination: 60 Marks												
Instruction for paper setter:												
1. There should be 9 questions in the term end examinations question paper.												
2. The first question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type questions of total 20 marks.												
3. Apart from question one which is compulsory, rest of the paper shall consist of four 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 up to five 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 objectives of course/paper. The standard /level of the questions to be asked should be at the level of the prescribed text book.												
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required												
Course Outcome (CO):												
CO 1	Able to Understand of MOSFET theory and VLSI design rules.											
CO 2	Able to Understand MOSFET fabrication and CMOS process flow.											
CO 3	Able to understand basics of Digital Integrate circuits design.											
CO 4	Able to understand basics analog Integrated circuits design.											
Course Outcomes (CO) to Programme Outcomes (PO) Mapping (Scale - 1: Low, 2: medium, 3: High)												
CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	3	2	1	1	-	2	1	-	2
CO 2	3	3	3	3	2	1	1	-	2	1	-	2
CO 3	3	3	3	3	2	1	1	-	2	1	-	2
CO 4	3	3	3	3	2	1	1	-	2	1	-	2

Unit 1

Introduction: Evolution of VLSI technology, trends in VLSI, Design abstraction levels in digital circuits.

MOS Transistor Theory: MOS Structure, MOS System Under External Bias, Structure and Operation of MOSFET, Current Voltage Characteristics, MOS device design equations, Channel length modulation, Substrate bias effect, MOSFET Scaling and Small Geometry Effects, MOSFET Capacitances. SPICE Models for the MOS Transistor, The BSIM3V3 SPICE Model

Unit 2

Fabrication Process Flow: Basic steps, fabrication of nMOS; Manufacturing CMOS Integrated Circuits: The Silicon Wafer, Photolithography, Diffusion and Ion Implantation, Deposition; The CMOS n-Well Process flow; Layout Design Rules, Full- Custom Mask Layout Design, CMOS inverter layout design, Stick diagram; Packaging Integrated Circuits: material, interconnect levels, thermal considerations

Unit 3

Digital circuit: Resistive Load & Active Load MOS Inverters, NMOS Inverters, CMOS Inverters: Static Characteristics, Switching Characteristics, Interconnect Parasitic, Propagation Delay, Static and Dynamic Power Dissipation, Noise Margin, Logic Threshold Voltage.

Combinational Circuits: MOS Logic Circuits with Depletion NMOS loads, CMOS Logic Circuits, CMOS logic Styles, Realization of simple gates, Complex logic circuits, Pass Gate, Transmission Gate.

Unit 4

MOS Analog Circuits: MOS Small Signal model, MOS as an Amplifier, Calculation of the DC Bias Point, Voltage Gain, Transconductance, Modelling the Body Effect, Biasing of Discrete MOS Amplifiers and Integrated Circuit MOS Amplifiers, Common Source Amplifier

Text Books

1. Kang S.M. and Yusuf Leblebici, CMOS Digital Integrated Circuits, Mc Graw Hill, 4th Edition 2019
2. Sedra and Smith, Microelectronic Circuits, Oxford University Press, 8th Edition, 2020.

Reference Books

1. Jan M Rabaey and Anantha P. Chandrakasan, Borivoje Nikolic Digital Integrated Circuits, Pearson, 2ND edition, 2016.
2. David Harris and Neil Weste, CMOS VLSI Design: A circuits and system perspective, Pearson, 2018.
3. Behzad Razavi, Analog CMOS, Mc Graw Hill, 2nd Edition 2017.