PRESIDENCY UNIVERSITY

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PROGRAMME REGULATIONS & CURRICULUM

2025-27

PRESIDENCY SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

MASTER OF TECHNOLOGY (M.TECH.) IN COMPUTER SCIENCE AND ENGINEERING SPECIALIZATION IN ARTIFICIAL INTELLIGENCE

PRESIDENCY UNIVERSITY

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50 YEARS

PRESIDENCY SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

Program Regulations and Curriculum

2025-2027

MASTER OF TECHNOLOGY (M.Tech.) in

COMPUTER SCIENCE AND ENGINEERING

Specialization in

Artificial Intelligence

based on Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

PRESIDENCY UNIVERSITY

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PART A – PROGRAM REGULATIONS

1. Vision & Mission of the University and the School / Department

1.1 Vision of the University

To be a Value-driven Global University, excelling beyond peers and creating professionals of integrity and character, having concern and care for society.

1.2 Mission of the University

- Commit to be an innovative and inclusive institution by seeking excellence in teaching, research and knowledge-transfer.
- Pursue Research and Development and its dissemination to the community, at large.
- Create, sustain and apply learning in an interdisciplinary environment with consideration for ethical, ecological and economic aspects of nation building.
- Provide knowledge-based technological support and services to the industry in its growth and development.
- To impart globally-applicable skill-sets to students through flexible course offerings and support industry's requirement and inculcate a spirit of new-venture creation.

1.3 Vision of Presidency School of Computer Science and Engineering

To be a value-based, practice-driven Presidency School of Computer Science and Engineering, committed to developing globally competent engineers, dedicated to developing cutting-edge technology to enhance the quality of life.

1.4 Mission of Presidency School of Computer Science and Engineering

- Cultivate a practice-driven environment with computing-based pedagogy, integrating theory and practice.
- Attract and nurture world-class faculty to excel in teaching and research in the realm of computing sciences.
- Establish state-of-the-art computing facilities for effective teaching and learning experiences.
- Promote interdisciplinary studies to nurture talent for global impact.
- Instill entrepreneurial and leadership skills to address social, environmental and community needs.

2. Preamble to the Program Regulations and Curriculum

This is the subset of Academic Regulations and it is to be followed as a requirement for the award of M.Tech degree.

The Curriculum is designed to take into the factors listed in the Choice Based Credit System (CBCS) with focus on Social Project Based Learning, Industrial Training, and Internship to enable the students to become eligible and fully equipped for employment in industries, choose higher studies or entrepreneurship.

In exercise of the powers conferred by and in discharge of duties assigned under the relevant provision(s) of the Act, Statutes and Academic Regulations of the University, the Academic Council hereby makes the following Regulations.

3. Short Title and Applicability

a. These Regulations shall be called the Master of Technology Degree Program Regulations and Curriculum 2025-2027.
b. These Regulations are subject to, and pursuant to the Academic Regulations.
c. These Regulations shall be applicable to the ongoing Master of Technology Degree Programs of the 2025-2027 batch, and to all other Master of Technology Degree Programs which may be introduced in future.
d. These Regulations shall supersede all the earlier Master of Technology Degree Program Regulations and Curriculum, along with all the amendments thereto.
e. These Regulations shall come into force from the Academic Year 2024-2025.

4. Definitions

In these Regulations, unless the context otherwise requires:

a. *"Academic Calendar" means the schedule of academic and miscellaneous events as approved by the Vice Chancellor;*
b. *"Academic Council" means the Academic Council of the University;*
c. *"Academic Regulations" means the Academic Regulations, of the University;*
d. *"Academic Term" means a Semester or Summer Term;*
e. *"Act" means the Presidency University Act, 2013;*
f. *"AICTE" means All India Council for Technical Education;*
g. *"Basket" means a group of courses bundled together based on the nature/type of the course;*
h. *"BOE" means the Board of Examinations of the University;*
i. *"BOG" means the Board of Governors of the University;*
j. *"BOM" means the Board of Management of the University;*
k. *"BOS" means the Board of Studies of a particular Department/Program of Study of the University;*
l. *"CGPA" means Cumulative Grade Point Average as defined in the Academic Regulations;*
m. *"Clause" means the duly numbered Clause, with Sub-Clauses included, if any, of these Regulations;*
n. *"COE" means the Controller of Examinations of the University;*
o. *"Course In Charge" means the teacher/faculty member responsible for developing and organising the delivery of the Course;*
p. *"Course Instructor" means the teacher/faculty member responsible for teaching and evaluation of a Course;*
q. *"Course" means a specific subject usually identified by its Course-code and Course-*

title, with specified credits and syllabus/course-description, a set of references, taught by some teacher(s)/course-instructor(s) to a specific class (group of students) during a specific Academic Term;

r. *"Curriculum Structure" means the Curriculum governing a specific Degree Program offered by the University, and, includes the set of Baskets of Courses along with minimum credit requirements to be earned under each basket for a degree/degree with specialization/minor/honours in addition to the relevant details of the Courses and Course catalogues (which describes the Course content and other important information about the Course). Any specific requirements for a particular program may be brought into the Curriculum structure of the specific program and relevant approvals should be taken from the BOS and Academic Council at that time.*

s. *"DAC" means the Departmental Academic Committee of a concerned Department/Program of Study of the University;*

t. *"Dean" means the Dean / Director of the concerned School;*

u. *"Degree Program" includes all Degree Programs;*

v. *"Department" means the Department offering the degree Program(s) / Course(s) / School offering the concerned Degree Programs / other Administrative Offices;*

w. *"Discipline" means specialization or branch of M.Tech. Degree Program;*

x. *"HOD" means the Head of the concerned Department;*

y. *"L-T-P-C" means Lecture-Tutorial-Practical-Credit – refers to the teaching – learning periods and the credit associated;*

z. *"MOOC" means Massive Open Online Courses;*

aa. *"MOU" means the Memorandum of Understanding;*

bb. *"NPTEL" means National Program on Technology Enhanced Learning;*

cc. *"Parent Department" means the department that offers the Degree Program that a student undergoes;*

dd. *"Program Head" means the administrative head of a particular Degree Program/s;*

ee. *"Program Regulations" means the Master of Technology Degree Program Regulations and Curriculum, 2025-2027;*

ff. *"Program" means the Masterr of Technology (M.Tech.) Degree Program;*

gg. *"PSCS" means the Presidency School of of Computer Science and Engineering;*

hh. *"Registrar" means the Registrar of the University;*

ii. *"School" means a constituent institution of the University established for monitoring, supervising and guiding, teaching, training and research activities in broadly related fields of studies;*

jj. *"Section" means the duly numbered Section, with Clauses included in that Section, of these Regulations;*

kk. *"SGPA" means the Semester Grade Point Average as defined in the Academic Regulations;*

ll. *"Statutes" means the Statutes of Presidency University;*

mm. *"Sub-Clause" means the duly numbered Sub-Clause of these Program*

Regulations;

nn. "Summer Term" means an additional Academic Term conducted during the summer break (typically in June-July) for a duration of about eight (08) calendar weeks, with a minimum of thirty (30) University teaching days;

oo. "SWAYAM" means Study Webs of Active Learning for Young Aspiring Minds.

pp. "UGC" means University Grant Commission;

qq. "University" means Presidency University, Bengaluru; and

rr. "Vice Chancellor" means the Vice Chancellor of the University.

5. Program Description

The Master of Technology Degree Program Regulations and Curriculum 2025-2027 are subject to, and, pursuant to the Academic Regulations. These Program Regulations shall be applicable to the following ongoing Master of Technology (M.Tech.) Degree Programs of 2025-2027 offered by the Presidency School of Engineering (PSOE):

1. Master of Technology in Computer Science and Engineering Specialization in Artificial Intelligence.M.Tech. (AIE)
2. Master of Technology in Computer Science and Engineering Specialization in Data Science.M.Tech. (DSC)

5.1 These Program Regulations shall be applicable to other similar programs, which may be introduced in future.

5.2 These Regulations may evolve and get amended or modified or changed through appropriate approvals from the Academic Council, from time to time, and shall be binding on all concerned.

5.3 The effect of periodic amendments or changes in the Program Regulations, on the students admitted in earlier years, shall be dealt with appropriately and carefully, so as to ensure that those students are not subjected to any unfair situation whatsoever, although they are required to conform to these revised Program Regulations, without any undue favour or considerations

6. Minimum and Maximum Duration

6.1 Master of Technology Degree Program is a Two-Year, Full-Time Semester based program. The minimum duration of the M.Tech. Program is four (02) years and each year comprises of two academic Semesters (Odd and Even Semesters) and hence the duration of the M.Tech. program is four (04) Semesters.

6.2 A student who for whatever reason is not able to complete the Program within the normal period or the minimum duration (number of years) prescribed for the Program, may be allowed a period of two years beyond the normal period to complete the mandatory minimum credits requirement as prescribed by the

concerned Program Regulations and Curriculum. In general, the permissible maximum duration (number of years) for completion of Program is 'N' + 2 years, where 'N' stands for the normal or minimum duration (number of years) for completion of the concerned Program as prescribed by the concerned Program Regulations and Curriculum.

6.3 The time taken by the student to improve Grades/CGPA, and in case of temporary withdrawal/re-joining (Refer to Clause 16.1 of Academic Regulations), shall be counted in the permissible maximum duration for completion of a Program.

6.4 In exceptional circumstances, such as temporary withdrawal for medical exigencies where there is a prolonged hospitalization and/or treatment, as certified through hospital/medical records, women students requiring extended maternity break (certified by registered medical practitioner), and, outstanding sportspersons representing the University/State/India requiring extended time to participate in National/International sports events, a further extension of one (01) year may be granted on the approval of the Academic Council.

6.5 The enrolment of the student who fails to complete the mandatory requirements for the award of the concerned Degree (refer Section 19.0 of Academic Regulations) in the prescribed maximum duration (Sub-Clauses 18.1 and 18.2 of Academic Regulations), shall stand terminated and no Degree shall be awarded.

7 Programme Educational Objectives (PEO)

After four years of successful completion of the program, the graduates shall be:

PEO 01: To prepare graduates who will be successful professionals in industry, government, academia, research, entrepreneurial pursuit and consulting firms.

PEO 02: To prepare graduates who will contribute to society as broadly educated, expressive, ethical and responsible citizens with proven expertise.

PEO 03: To prepare graduates who will achieve peer recognition as individuals or in a team through demonstration of good analytical, research, design and implementation skills.

PEO 04: To prepare graduates who will thrive to pursue life-long reflective learning to fulfil their goals.

8 Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

8.1 Programme Outcomes (PO)

On successful completion of the Program, the students shall be able to:

PO1:An ability to analysis, manage and supervise engineering systems and processes with the aid of appropriate advanced tools.

PO2:An ability to design a system and process within constraints of health, safety, security, economics, manufacturability to meet desired needs.

PO3:An ability to carry out research in the respective discipline and publish the findings.

PO4:An ability to effectively communicate and transfer the knowledge/ skill to stakeholders.

PO5:An ability to realize the impact of engineering solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.

8.2 Program Specific Outcomes (PSOs):

On successful completion of the Program, the students shall be able to:

PSO 1:

Apply core and advanced concepts of Artificial Intelligence to design and develop intelligent solutions addressing complex, real-world challenges across interdisciplinary domains.

PSO 2:

Engage in independent research, innovation, and entrepreneurial pursuits in the field of intelligent systems, contributing to academic, industrial, and societal advancement.

PSO 3:

Demonstrate the ability to conceptualize and implement ethical, responsible, and socially beneficial AI applications, ensuring transparency, fairness, and accountability.

9 Admission Criteria (as per the concerned Statutory Body)

The University admissions shall be open to all persons irrespective of caste, class, creed, gender or nation. All admissions shall be made on the basis of merit in the qualifying examinations; provided that forty percent of the admissions in all Programs of the University shall be reserved for the students of Karnataka State and admissions shall be made through a Common Entrance Examination conducted by the State Government or its agency and seats shall be allotted as per the merit and reservation policy of the State Government from time to time**.** The admission criteria to the M.Tech. Program is listed in the following Sub-Clauses:

- Have a Bachelor's degree in engineering (B.E./B.Tech) from a recognized university.
- Have a minimum aggregate of 50% in your Bachelor's degree.
- Have a minimum aggregate of 45% in your Bachelor's degree if you belong to a reserved category.
- Have to submit score card from any state or central entrance exam or the Presidency University admission qualifying exam

10. Specific Regulations regarding Assessment and Evaluation (including the Assessment Details of NTCC Courses, Weightages of Continuous Assessment and End Term Examination for various Course Categories)

10.1 The academic performance evaluation of a student in a Course shall be according to the University Letter Grading System based on the class performance distribution in the Course.

10.2 Academic performance evaluation of every registered student in every Course registered by the student is carried out through various components of Assessments spread across the Semester. The nature of components of Continuous Assessments and the weightage given to each component of Continuous Assessments (refer Clause 8.8 of academic regulations) shall be clearly defined in the Course Plan for every Course, and approved by the DAC.

10.3 Format of the End-Term examination shall be specified in the Course Plan.

10.4 Grading is the process of rewarding the students for their overall performance in each Course. The University follows the system of Relative Grading with statistical approach to classify the students based on the relative performance of the students registered in the concerned Course except in the following cases:

- Non-Teaching Credit Courses (NTCC)

Absolute grading method may be adopted, where necessary with prior approval of concerned DAC.

Grading shall be done at the end of the Academic Term by considering the aggregate performance of the student in all components of Assessments prescribed for the Course. Letter Grades shall be awarded to a student based on her/his overall performance relative to the class performance distribution in the concerned Course. These Letter Grades not only indicate a qualitative assessment of the student's performance but also carry a quantitative (numeric) equivalent called the Grade Point.

10.5 Assessment Components and Weightage

Table 1: Assessment Components and Weightage for different category of Courses

Nature of Course and Structure	Evaluation Component	Weightage
Lecture-based Course L component in the L-T-P Structure is predominant (more than 1) (Examples: 3-0-0; 3-0-2; 2-1-0; 2-0-2, 2-0-4 etc.)	Continuous Assessments	50%
	End Term Examination	50%
Lab/Practice-based Course	Continuous Assessments	50%

P component in the L-T-P Structure is predominant (Examples: 0-0-4; 1-0-4; 1-0-2; etc.)	End Term Examination	50%
Skill based Courses like Industry Internship, Capstone project, Research Dissertation, Integrative Studio, Interdisciplinary Project, Summer / Short Internship, Social Engagement / Field Projects, Portfolio, and such similar Non-Teaching Credit Courses, where the pedagogy does not lend itself to a typical L-T-P structure	Guidelines for the assessment components for the various types of Courses, with recommended weightages, shall be specified in the concerned Program Regulations and Curriculum / Course Plans, as applicable.	

The exact weightages of Evaluation Components shall be clearly specified in the concerned PRC and respective Course Plan.

Normally, for Practice/Skill based Courses, without a defined credit structure (L–P–C) [NTCC], but with assigned Credits (as defined in Clause 5.2 of the Academic Regulations), the method of evaluation shall be based only on Continuous Assessments. The various components of Continuous Assessments, the distribution of weightage among such components, and the method of evaluation/assessment, shall be as decided and indicated in the Course Plan/PRC. The same shall be approved by the respective DAC.

10.6 Minimum Performance Criteria:

10.6.1 Theory only Course and Lab/Practice Embedded Theory Course

A student shall satisfy the following minimum performance criteria to be eligible to earn the credits towards the concerned Course:

a. A student must obtain a minimum of 30% of the total marks/weightage assigned to the End Term Examinations in the concerned Course.

b. The student must obtain a minimum of 40% of the AGGREGATE of the marks/weightage of the components of Continuous Assessments, Mid Term Examinations and End Term Examinations in the concerned Course.

10.6.2 Lab/Practice only Course and Project Based Courses

The student must obtain a minimum of 40% of the AGGREGATE of the marks/weightage of all assessment components in the concerned Course.

10.6.3 A student who fails to meet the minimum performance criteria listed above in a Course shall be declared as "Fail" and given "F" Grade in the concerned Course. For theory Courses, the student shall have to re-appear in the "Make-Up Examinations" as scheduled by the University in any subsequent semester, or, re-appear in the End Term Examinations of the same Course when it is scheduled at the end of the following Semester or Summer Term, if offered. The marks obtained in the Continuous Assessments (other than the End Term Examination) shall be carried forward and be included in computing the final grade, if the student secures the minimum requirements (as per sub-clause 8.9.1 and 8.9.2 of academic regulations) in the "Make-Up Examinations" of the concerned Course. Further, the student has an option to re-register for the Course and clear the same in the summer term/ subsequent semester if he/she wishes to do so, provided the Course is offered.

11 Additional clarifications - Rules and Guidelines for Transfer of Credits from MOOC, etc. – Note: These are covered in Academic Regulations

The University allows students to acquire credits from other Indian or foreign institutions and/or Massive Open Online Course (MOOC) platforms, subject to prior approval. These credits may be transferred and counted toward fulfilling the minimum credit requirements for the award of a degree. The process of transfer of credits is governed by the following rules and guidelines:

11.1 The transfer of credits shall be examined and recommended by the Equivalence Committee (Refer ANNEXURE B of academic regulations) and approved by the Dean - Academics.

11.2 Students may earn credits from other Indian or foreign Universities/Institutions with which the University has an MOU, and that MOU shall have specific provisions, rules and guidelines for transfer of credits. These transferred credits shall be counted towards the minimum credit requirements for the award of the degree.

11.3 Students may earn credits by registering for Online Courses offered by *Study Web of Active Learning by Young and Aspiring Minds* (SWAYAM) and *National Program on Technology Enhanced Learning* (NPTEL), or other such recognized Bodies/ Universities/Institutions as approved by the concerned BOS and Academic Council from time to time. The concerned School/Parent Department shall publish/include the approved list of Courses and the rules and guidelines governing such transfer of credits of the concerned Program from time to time. The Rules and Guidelines for the transfer of credits specifically from the Online Courses conducted by SWAYAM/ NPTEL/ other approved MOOCs are as stated in the following Sub-Clauses:

11.3.1 A student may complete SWAYAM/NPTEL/other approved MOOCs as mentioned in Clause 11.3 (as per academic regulations) and transfer equivalent credits to partially or fully complete the mandatory credit requirements of Discipline Elective Courses and/or the mandatory credit requirements of Open Elective Courses as prescribed in the concerned Curriculum Structure. However, it is the sole responsibility of the student to complete the mandatory credit requirements of the Discipline Elective Courses and the Open Elective Courses as prescribed by the Curriculum Structure of the concerned Program.

11.3.2 SWAYAM/NPTEL/ other approved MOOCs as mentioned in Clause 11.3 (as per academic regulations) shall be approved by the concerned Board of Studies and placed (as Annexures) in the concerned PRC.

11.3.3 Parent Departments may release a list of SWAYAM/NPTEL/other approved MOOCs for Pre-Registration as per schedule in the Academic Calendar or through University Notification to this effect.

11.3.4 Students may Pre-Register for the SWAYAM/NPTEL/other approved MOOCs in the respective Departments and register for the same Courses as per the schedule announced by respective Online Course Offering body/institute/ university.

11.3.5 A student shall request for transfer of credits only from such approved Courses as mentioned in Sub-Clause 11.3.2 above.

11.3.6 SWAYAM/NPTEL/other approved MOOCs Courses are considered for transfer of credits only if the concerned student has successfully completed the SWAYAM/NPTEL/other approved MOOCs and obtained a certificate of successful/satisfactory completion.

11.3.7 A student who has successfully completed the approved SWAYAM/NPTEL/ other approved MOOCs and wants to avail the provision of transfer of equivalent credits, must submit the original Certificate of Completion, or such similar authorized documents to the HOD concerned, with a written request for the transfer of the equivalent credits. On verification of the Certificates/Documents and approval by the HOD concerned, the Course(s) and equivalent Credits shall forwarded to the COE for processing of results of the concerned Academic Term.

11.3.8 The credit equivalence of the SWAYAM/NPTEL/other approved MOOCs are based on Course durations and/or as recommended by the Course offering body/institute/university. The Credit Equivalence mapped to SWAYAM/ NPTEL approved Courses based on Course durations for

transfer of credits is summarised in Table shown below. The Grade will be calculated from the marks received by the Absolute Grading Table 8.11 in the academic regulations.

Table 2: Durations and Credit Equivalence for Transfer of Credits from SWAYAM-NPTEL/ other approved MOOC Courses

Sl. No.	Course Duration	Credit Equivalence
1	4 Weeks	1 Credit
2	8 Weeks	2 Credits
3	12 Weeks	3 Credits

11.3.9 The maximum permissible number of credits that a student may request for credit transfer from MOOCs shall not exceed 20% of the mandatory minimum credit requirements specified by the concerned Program Regulations and Curriculum for the award of the concerned Degree.

11.3.10 The University shall not reimburse any fees/expense; a student may incur for the SWAYAM/NPTEL/other approved MOOCs.

11.4 The maximum number of credits that can be transferred by a student shall be limited to forty percent (40%) of the mandatory minimum credit requirements specified by the concerned Program Regulations and Curriculum for the award of the concerned Degree. However, the grades obtained in the Courses transferred from other Institutions/MOOCs, as mentioned in this Section (11.0), shall not be included in the calculation of the CGPA.

PART B: PROGRAM STRUCTURE

12.0 Structure / Component with Credit Requirements Course Baskets & Minimum Basket wise Credit Requirements

The M.Tech. CSE Specialization in (Artificial Intelligence) Program Structure (2025-2027) totalling 68credits. Table 3 summarizes the type of baskets, number of courses under each basket and the associated credits that are mandatorily required for the completion of the Degree.

Table 3: Summary of mandatory courses and minimum credit contribution from various baskets

S.No	Baskets	Credit Contribution
1	SCHOOL CORE	32
2	PROGRAM CORE	15
3	DISCIPLINE ELECTIVE	15
4	OPEN ELECTIVE	06
	TOTAL CREDITS	**Min. 68**

In the entire Program, the practical and skill based course component contribute to an extent of approximately 61% out of the total credits of 68 for M.Tech. (Product Design and Development) program of twoyears' duration.

13. Minimum Total Credit Requirements of Award of Degree

As per the AICTE guidelines, a minimum of 68 credits is required for the award of a M.Tech. degree.

14. Other Specific Requirements for Award of Degree, if any, as prescribed by the Statutory Bodies,

14.1 The award of the Degree shall be recommended by the Board of Examinations and approved by the Academic Council and Board of Management of the University**.**

14.2 A student shall be declared to be eligible for the award of the concerned Degree if she/he:

a. Fulfilled the Minimum Credit Requirements and the Minimum Credits requirements under various baskets;

b. Secure a minimum CGPA of 5.0 in the concerned Program at the end of the Semester/Academic Term in which she/he completes all the requirements for the award of the Degree as specified in Sub-clause 19.2.1 a of Academic Regulations**;**

c. No dues to the University, Departments, Hostels, Library, and any other such Centers/ Departments of the University; and

d. No disciplinary action is pending against her/him.

PART C: CURRICULUM STRUCTURE

15.Curriculum Structure – Basket Wise Course List (not Semester Wise)
List of Courses Tabled – aligned to the Program Structure
(Course Code, Course Name, Credit Structure (LTPC), Contact Hours, Course Basket, Type of Skills etc., as applicable).

Type of Skill
F - Foundation S - Skill Development EM – Employability EN – Entrepreneurship

Course Caters to
GS - Gender Sensitization ES - Environment and sustainability HP - Human values and Professional Ethics

Table 3.1 : List of School Core Courses (SC)

S. No	Course Code	Course Name	L	T	P	C	Contact Hours	Type of Skills	Pre requisite
1	MAT4004	Advanced Engineering Mathematics	3	0	0	3	3	S	-
2	ENG5001	English for Employability	2	1	0	3	3	S	-
3	SEM7000	Seminar	-	-	-	1		S/EM	-
4	PIP7500	Dissertation/ Internship – I	-	-	-	10		S/EM	-
5	PIP7501	Dissertation/ Internship – II	-	-	-	14		S/EM	-
		Total No. of Credits				**31**			

Table 3.2 : List of Programme Core Courses (PC)

S.No	Course Code	Course Name	L	T	P	C	Contact Hours	Type of Skills	Pre requisite
1	AIE4000	Knowledge Engineering and Expert Systems	3	0	0	3	3	S	-
2	AIE4001	Artificial Intelligence	2	0	2	3	4	S	-
3	AIE4002	Machine Learning Algorithms	2	0	2	3	4	S	-

4	AIE4003	Deep Learning	2	0	2	3	4	S	-
5	AIE4504	Natural Language Processing Techniques	2	0	2	3	4	S	-
		Total No. of Credits				**15**			

16. Practical / Skill based Courses – Internships / Thesis / Dissertation / Capstone Project Work / Portfolio / Mini project

Practical / Skill based Courses like internship, project work, capstone project, research project / dissertation, and such similar courses, where the pedagogy does not lend itself to a typical L-T-P-C Structure as defined in Clause 5.1 of the Academic Regulations are simply assigned the number of Credits based on the quantum of work / effort required to fulfill the learning objectives and outcomes prescribed for the concerned Courses. Such courses are referred to as Non-Teaching Credit Courses (NTCC). These Courses are designed to provide students with hands-on experience and skills essential for their professional development. These courses aim to equip students with abilities in problem identification, root cause analysis, problem-solving, innovation, and design thinking through industry exposure and project-based learning. The expected outcomes are first level proficiency in problem solving and design thinking skills to better equip M.Tech. graduates for their professional careers. The method of evaluation and grading for the Practical / Skill based Courses shall be prescribed and approved by the concerned Departmental Academic Committee (refer Annexure A of the Academic Regulations). The same shall be prescribed in the Course Handout.

16.1 Internship

A student may undergo an Internship for a period of 12-14 weeks in an industry / company or academic / research institution during 3rd and 4th Semesters, subject to the following conditions:

16.1.1 The Internship shall be in conducted in accordance with the Internship Policy prescribed by the University from time to time.

16.1.2 The selection criteria (minimum CGPA, pass in all Courses as on date, and any other qualifying criteria) as applicable / stipulated by the concerned Industry / Company or academic / research institution for award of the Internship to a student;

16.1.3 The number of Internships available for the concerned Academic Term. Further, the available number of internships shall be awarded to the students by the University on the basis of merit using the CGPA secured by the student. Provided further, the student fulfils the criteria, as applicable, specified by the Industry / Company or academic / research institution providing the

Internship, as stated in Sub-Clause 16.1.2 above.

16.1.4 A student may opt for Internship in an Industry / Company or academic / research institution of her / his choice, subject to the condition that the concerned student takes the responsibility to arrange the Internship on her / his own. Provided further, that the Industry / Company or academic / research institution offering such Internship confirms to the University that the Internship shall be conducted in accordance with the Program Regulations and Internship Policy of the University.

16.1.5 A student selected for an Internship in an industry / company or academic / research institution shall adhere to all the rules and guidelines prescribed in the Internship Policy of the University.

16.2 Project Work

A student may opt to do a Project Work for a period of 12-15 weeks in an Industry / Company or academic / research institution or the University Department(s) as an equivalence of Internship during the 3rd and 4th Semester as applicable, subject to the following conditions:

16.2.1 The Project Work shall be approved by the concerned HOD and be carried out under the guidance of a faculty member.

16.2.2 The student may do the project work in an Industry / Company or academic / research institution of her / his choice subject to the above mentioned condition (Sub-Clause 16.2.1). Provided further, that the Industry / Company or academic / research institution offering such project work confirms to the University that the project work will be conducted in accordance with the Program Regulations and requirements of the University.

16.3 Capstone Project

A student may undergo a Capstone Project for a period of 12-14 weeks in an industry / company or academic / research institution in the 4th Semester as applicable, subject to the following conditions:

16.3.1 The Capstone Project shall be in conducted in accordance with the Capstone Project Policy prescribed by the University from time to time.

16.3.2 The selection criteria (minimum CGPA, pass in all Courses as on date, and

any other qualifying criteria) as applicable / stipulated by the concerned Industry / Company or academic / research institution for award of the Capstone Project to a student;

16.3.3 The number of Capstone Project available for the concerned Academic Term. Further, the available number of Capstone Project shall be awarded to the students by the University on the basis of merit using the CGPA secured by the student. Provided further, the student fulfils the criteria, as applicable, specified by the Industry / Company or academic / research institution providing the Capstone Project, as stated in Sub-Clause 16.3.2 above.

16.3.4 A student may opt for Capstone Project in an Industry / Company or academic / research institution of her / his choice, subject to the condition that the concerned student takes the responsibility to arrange the I Capstone Project on her / his own. Provided further, that the Industry / Company or academic / research institution offering such Capstone Project confirms to the University that the Capstone Project shall be conducted in accordance with the Program Regulations and Capstone project Policy of the University.

16.3.5 A student selected for a Capstone Project in an industry / company or academic / research institution shall adhere to all the rules and guidelines prescribed in the Capstone Project Policy of the University.

16.4 Research Project / Dissertation

A student may opt to do a Research Project / Dissertation for a period of 12-14 weeks in an Industry / Company or academic / research institution or the University Department(s) as an equivalence of Capstone Project, subject to the following conditions:

16.4.1 The Research Project / Dissertation shall be approved by the concerned HOD and be carried out under the guidance of a faculty member.

The student may do the Research Project / Dissertation in an Industry / Company or academic / research institution of her / his choice subject to the above mentioned condition (Sub-Clause 18.4.1). Provided further, that the Industry / Company or academic / research institution offering such Research Project / Dissertation confirms to the University that the Research Project / Dissertation work will be conducted in accordance with the Program Regulations and requirements of the University.

17.List of Discipline Elective Courses:

Table 3.3 DISCIPLINE ELECTIVE - Minimum of 15 Credits to be earned from this basket

Sl. No.	Course Code	Course Name	L	T	P	C	Contact Hours	Type of Skill/ Focus	Prerequisites/ Corequisites
1	DSC4011	Data Science with Cloud Computing	3	0	0	3	3	S	-
2	DSC4012	Data Security and Access Control	3	0	0	3	3	S	-
3	DSC4013	Soft Computing Techniques	3	0	0	3	3	S	-
4	DSC4014	Time Series Analysis and Forecasting	3	0	0	3	3	S	-
5	DSC4015	IOT Data Analytics	3	0	0	3	3	S	-
6	DSC4016	Probabilistic Graph Models	3	0	0	3	3	S	-
7	DSC4017	Social Network Analysis	3	0	0	3	3	S	-
8	DSC4018	Application of Probability theory in Computer Science	3	0	0	3	3	S	-
9	DSC4019	Digital Image Processing	2	0	2	3	4	S	-
10	DSC4020	Data Mining and Pattern Recognition	2	0	2	3	4	S	-
11	DSC4021	Graph Analytics and Network Science	2	0	2	3	4	S	-
12	DSC4022	Geospatial Data Science	2	0	2	3	4	S	-
13	DSC4023	Marketing and Consumer Analytics	3	0	0	3	3	S	-
14	DSC4024	Multimodal Learning	2	0	2	3	4	S	-
15	DSC4025	Intelligent Decision Support Systems	2	0	2	3	4	S	-

16	AIE4011	Robotic Process Automation	3	0	0	3	3	S	-
17	AIE4012	Machine Vision	3	0	0	3	3	S	-
18	AIE4013	Cloud Computing	3	0	0	3	3	S	-
19	AIE4014	Ontology Engineering for the Semantic Web	3	0	0	3	3	S	-
20	AIE4015	Intelligent Information Retrieval	3	0	0	3	3	S	-
21	AIE4016	Internet of Things	3	0	0	3	3	S	-
22	AIE4017	Essentials for Machine Learning	3	0	0	3	3	S	-
23	AIE4018	Recommender Systems with Machine Learning and AI	3	0	0	3	3	S	-
24	AIE4019	Green Computing and Sustainable IT	3	0	0	3	3	S	-
25	AIE4020	Reinforcement Learning	2	0	2	3	4	S	-
26	AIE4021	AI Ethics and Responsible AI	2	0	2	3	4	S	-
27	AIE4022	Generative AI and Foundation Models	2	0	2	3	4	S	-
28	AIE4023	Explainable AI	2	0	2	3	4	S	-
29	AIE4024	Digital Twins	2	0	2	3	4	S	-
30	AIE4025	Quantum Computing	2	0	2	3	4	S	-

18. List of Open Electives to be offered by the School / Department (Separately for ODD and EVEN Semesters.

Table 3.4 Open Elective Courses Minimum of 6 Credits to be earned from this basket									
Civil Engineering Basket									
Sl. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Contact Hours**	Type of Skills	**Prerequisites**

1	CIV5001	Sustainable Smart Cities	3	0	0	3	3	EM	-
2	CIV5002	Systems Design for Sustainability	3	0	0	3	3	EM	-
3	CIV5003	SelfSustainable Buildings	3	0	0	3	3	EM	-
4	CIV5004	Energy and Buildings	3	0	0	3	3	EM	-
Law Basket									
1	LAW5001	International Trade Law	3	0	0	3	3	-	-
2	LAW5002	Law relating to Business Establishment	3	0	0	3	3	-	-
3	LAW5003	Data Protection Law	3	0	0	3	3	-	-
4	LAW5004	Law Relating to Consumer Protection	3	0	0	3	3	-	-
5	LAW5005	Law Relating to Infrastructure Projects	3	0	0	3	3	-	-
Computer Science and Engineering Basket									
1	CSE5001	Programming Methodologies using Java	3	0	0	3	3	-	-
2	CSE5002	Human Computer Interaction	3	0	0	3	3	-	-
3	CSE5003	IOT Applications	3	0	0	3	3	-	-
4	CSE5004	Programming Essentials in Python	3	0	0	3	3	-	-
Electronics and Communication Engineering Basket									

1	ECE5001	Wearable Computing	3	0	0	3	3	-	-
2	ECE5002	MEMS and Nanotechnology	3	0	0	3	3	-	-
3	ECE5003	Advanced Computer Networks	3	0	0	3	3	-	-
4	ECE5004	Pervasive Computing	3	0	0	3	3	-	-
Mechanical Engineering Basket									
1	MEC5001	Optimization Techniques	3	0	0	3	3	-	-
2	MEC5002	Industry 4.0	3	0	0	3	3	EM	-
3	MEC5003	Six Sigma for Engineers	3	0	0	3	3	-	-
4	MEC5004	Design for Internet of Things	3	0	0	3	3	-	-
Management Basket									
1	MBA3042	Innovation and Business Incubation	3	0	0	3	3	-	-
2	MBA3037	Personal Wealth Management	3	0	0	3	3	-	-
3	MBA3038	Team Dynamics	3	0	0	3	3	-	-
4	MBA3039	Market Research	3	0	0	3	3	-	-
5	MBA2023	Design Thinking for Business Innovation	3	0	0	3	3	-	-
6	MBA3046	Game Theory in Business	3	0	0	3	3	-	-

7	MBA3047	Data Story Telling	3	0	0	3	3	-	-
8	MBA3048	Environmental Sustainability and Value Creation	3	0	0	3	3	-	-
9	MBA3049	Industry 4.0	3	0	0	3	3	-	-
Media Studies Basket									
1	BAJ5001	Media and Entertainment Business	3	0	0	3	3	EN	-
2	BAJ5002	TV Journalism and News Management	2	0	2	3	4	EM	-
Research Basket									
1	RES5001	Research Methodology	3	0	0	3	3	S	-
2	RES3001	Research Methodology	3	0	0	3	3	S	-
Research Project (Students are required to carry out research work under the guidance of a faculty member/ research scholar and the same shall be evaluated and credit will be granted as per the academic regulations)									
1	URE7001	University Research Experience	-	-	-	3		EM	-
2	URE7002	University Research Experience	-	-	-	0		EM	-
Apart from the above list, the student is free to enroll for any course offered by any school and earn credits for Open elective provided the student has not completed an antirequisite course and the student fulfills the prerequisite if any for the course he wishes to enroll									

Recommended Semester Wise Course Structure / Flow including the Programme / Discipline Elective Paths / Options

Sl. No.	Course Code	Course Name	L	T	P	Credits	Contact Hours	Basket
Semester 1						**22**	**25**	
1	MAT4004	Advanced Engineering Mathematics	4	0	0	4	4	School Core
2	ENG5001	English for Employability	2	1	0	3	3	School Core
3	AIE4000	Knowledge Engineering and Expert Systems	3	0	0	3	3	Program Core
4	AIE4001	Artificial Intelligence	2	0	2	3	4	Program Core
5	AIE4002	Machine Learning Algorithms	2	0	2	3	4	Program Core
6	xxxxxx	Discipline Elective - I	3	0	0	3	3	Discipline Elective
7	xxxxxx	Discipline Elective - II	2	0	2	3	4	Discipline Elective
Semester 2						**22**	**25**	
1	AIE4003	Deep Learning	2	0	2	3	4	Program Core
2	AIE4504	Natural Language Processing Techniques	2	0	2	3	4	Program Core
3	xxxxxx	Discipline Elective - III	2	0	2	3	4	Discipline Elective
4	xxxxxx	Discipline Elective - IV	3	0	0	3	3	Discipline Elective
5	xxxxxx	Discipline Elective - V	3	0	0	3	3	Discipline Elective
6	xxxxxx	Open Elective - I	3	0	0	3	3	Open Elective
7	xxxxxx	Open Elective - II	3	0	0	3	3	Open Elective
8	SEM7000	Seminar	-	-	-	1	1	School Core
Semester 3						**10**	**0**	
1	PIP7500	Dissertation/ Internship - I	-	-	-	10		School Core
Semester 4						**14**	**0**	
1	PIP7501	Dissertation/ Internship - II	-	-	-	14		School Core

I. Course Catalogues:

Each course shall have a course catalogue with the following details:

i) Pre –Requisites of the course
ii) Course Description
iii) Course Outcome
iv) Course Content
iv) Reference Resources.

The Course Catalogues for the Courses offered in each basket are attached below:

Course Code: PIP6001	**Course Title: Dissertation-I** **Type of Course:**	**L- T-P- C**	0	0	0	10
Version No.	**1.0**					
Course Pre-requisites	--					
Anti-requisites	**NIL**					
Course Description	Students observe science and technology in action, develop an awareness of the method of scientific experimentation, and often get an opportunity to see, study and operate sophisticated and costly equipment. They also learn about the implementation of the principles of management they have learnt in class, when they observe multidisciplinary teams of experts from engineering, science, economics, operations research, and management deal with techno-economic problems at the micro and macro levels. Finally, it enables them to develop and refine their language, communication and inter-personal skills, both by its very nature, and by the various evaluation components, such as seminar, group discussion, project report preparation, etc. The broad-based core education, strong in mathematics and science and rich in analytical tools, provides the foundation necessary for the student to understand properly the nature of real-life problems. The students have options to pursue this course as either Project Work and Dissertation at the university, or Project Work in an Industry/ Company/ Research Laboratory, or Internship Program in an Industry/Company.					
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Professional Practice and attain Employability Skills through Experiential Learning techniques.					

Course Outcomes	On successful completion of this course the students shall be able to: 1. Identify problems based on societal /research needs. (Understand) 2. Apply Knowledge and skill to solve societal problems in a group. (Apply) 3. Develop interpersonal skills to work as member of a group or leader. (Apply) 4. Analyze the inferences from available results through theoretical / Experimental / Simulations. (Analyze) 5. Analyze the impact of solutions in societal and environmental context for sustainable development. (Analyze) 6. Improve in written and oral communication. (Create) 7. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. (Understand)

Course Code: PIP6002	**Course Title: Dissertation-II** **Type of Course:**	**L- T-P- C**	0	0	0	14
Version No.	**1.0**					
Course Pre-requisites	--					
Anti-requisites	**NIL**					
Course Description	Students observe science and technology in action, develop an awareness of the method of scientific experimentation, and often get an opportunity to see, study and operate sophisticated and costly equipment. They also learn about the implementation of the principles of management they have learnt in class, when they observe multidisciplinary teams of experts from engineering, science, economics, operations research, and management deal with techno-economic problems at the micro and macro levels. Finally, it enables them to develop and refine their language, communication and inter-personal skills, both by its very nature, and by the various evaluation components, such as seminar, group discussion, project report preparation, etc. The broad-based core education, strong in mathematics and science and rich in analytical tools, provides the foundation necessary for the student to understand properly the nature of real-life problems. The students have options to pursue this course as either Project Work and Dissertation at the university, or Project Work in					

	an Industry/ Company/ Research Laboratory, or Internship Program in an Industry/Company.
Course Objectives	The objective of the course is to familiarize the learners with the concepts of Professional Practice and attain Employability Skills through Experiential Learning techniques.
Course Outcomes	On successful completion of this course the students shall be able to: 1. Identify problems based on societal /research needs. (Understand) 2. Apply Knowledge and skill to solve societal problems in a group. (Apply) 3. Develop interpersonal skills to work as member of a group or leader. (Apply) 4. Analyze the inferences from available results through theoretical / Experimental / Simulations. (Analyze) 5. Analyze the impact of solutions in societal and environmental context for sustainable development. (Analyze) 6. Improve in written and oral communication. (Create) 7. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. (Understand)

Course Code: SEM7000
Course Title: Seminar
Type of Course: L–T–P–C: 0–0–0–1
Version No.: 1.0
Course Pre-requisites: Nil
Anti-requisites: Nil

Course Description
This course is designed to enhance the research aptitude, presentation skills, and domain knowledge of postgraduate students. Students are required to select a recent topic related to their specialization, perform an extensive literature survey, and prepare a seminar report. The seminar is to be presented before a committee comprising faculty members and peers. This process fosters critical thinking, self-directed learning, and effective communication skills, while also promoting collaborative learning and peer feedback.

Course Objectives

- To develop the ability to conduct independent literature reviews and identify key issues in a chosen domain.
- To improve students' oral and written communication skills for technical and academic settings.
- To encourage active participation in academic discussions and constructive feedback.

Course Outcomes

Upon successful completion of this course, students will be able to:

1. **(Understand)** Identify and comprehend emerging research areas relevant to their field.
2. **(Apply)** Apply analytical skills to review and synthesize information from multiple sources.
3. **(Analyze)** Organize and structure academic content logically for presentation.
4. **(Create)** Prepare technical documents (seminar report) adhering to standard formats.
5. **(Apply)** Deliver an effective oral presentation using appropriate tools and techniques.
6. **(Evaluate)** Critically respond to questions and feedback from peers and faculty.
7. **(Understand)** Recognize the importance of continuous learning and staying updated in their field of study.

Course Code: AIE4000	**Course Title:** **KNOWLEDGE ENGINEERING AND EXPERT SYSTEM** **Type of Course:** **Program Core** **Theory Only**	**L- T- P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	--					
Anti-requisites	**NIL**					
Course Description	Knowledge engineering is a field within artificial intelligence that develops knowledge-based systems. Such systems are computer programs that contain large amounts of knowledge, rules and reasoning mechanisms to provide solutions to real-world problems. A major form of knowledge-based system is an expert system, one designed to emulate the reasoning processes of an expert practitioner. Topics includes: Introduction to Knowledge Engineering, Knowledge based Systems, Types of Knowledge-based systems, Knowledge acquisition, Knowledge representation and reasoning: Logic rules and representations, Semantic Networks, frames, Life cycle Methodologies, Uncertain Reasoning with confidence factor, Basic Structure and Architecture of Expert System. Tools used in Expert System.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Knowledge Engineering and Expert Systems and attain **Skill Development** through **Participative Learning** techniques.					
Course Outcomes	On successful completion of the course the students shall be able to: CO1.Explain the basic concepts in Knowledge Engineering and types of Knowledge based system. CO2.Discuss the process of acquiring the Knowledge from the human expert.					

		CO3.Apply the logical rules, Semantic Networks and Frames for representing the knowledge. CO4.Life Cycle and Methodologies applied to support the development of Knowledge based Systems. CO5.Explain how expert system deal with uncertainty and describes architecture and tools used.				
Course Content:						
Module 1	Introduction to Knowledge Engineering and Knowledge Base	Assignment	Analysis			**10 Sessions**
	Topics: Data, Information and Knowledge Skills of a Knowledge Engineering, Engineering, software engineering and knowledge engineering, Knowledge Engineering around the world. Introduction to Knowledge-Based Systems.					
Module 2	Knowledge Acquisition	Assignment	Analysis, Data Collection			**5 Sessions**
	Topics: Knowledge Engineering life cycle, , Knowledge acquisition - knowledge acquired from a human expert - purpose and types of Interviews in obtaining knowledge.					
Module 3	Knowledge Representation and Reasoning	Problem-Solving	Data analysis task			**9 Sessions**
	Topics: Using knowledge - Logic, rules and representation- Developing rule-based systems, Conceptual Networks.					
Module 4	Life Cycle and Methodologies	Assignment	Analysis			**9 Sessions**
	Topics: Need for methodologies- Blackboard architectures- Problem Solving Methods (PSMs)- GEMINI, POLITE, - The Hybrid Methodology (HyM)- Building a well-structured application using Aion BRE.					
Module 5	Uncertain Reasoning and Expert System	Assignment	Analysis			**10 Sessions**
	Topics: Uncertainty – Confidence factor- Expert System – Basic Structure, Architecture – Tools used Constructing Expert System, Rule-based system.					
	Targeted Applications & Tools that can be used:					

	After Completion of the course, student may get an opportunity to be a Knowledge engineer to design and develop Knowledge base with reference to Acquisition and to represent it. Expert System can be developed on real time application (To highlight a few) Medical Knowledge Automation, Chemical and Biological Synthesis, Mineral and Oil explorations, Planning and Scheduling. Space Defense, VLSI Design, Air traffic control, Equipment fault Diagnosis. Circuit Diagnosis and So on. **Tools: Programming tools for building Expert System.** • OPS 5 • EMYCIN • KAS • TEIRESIAS
	Project work/Assignment:
	Case Study Analysis: To Study, analyze and develop expert system on applications. **Term Assignments:** • **Comparative analysis on methods in Knowledge representations.** • **A short survey on techniques used to build Knowledge base.** • **Recent trends used in developing Expert System.**
	Text Book T1. "An introduction to knowledge engineering", Simon Kendal, Malcolm creen, Springer, 2007.(with Recent version copyright) T2. "An Overview of Expert System " William B. Gevarter,Dept. of Commerce,U.S , NBS, Washignton,D.C.
	References R1. "An introduction to knowledge engineering", Peter Smith, Thomson computer press, 1996. R2. "A guide to an Expert System ", Donald Waterman, Pearson India. **Weblinks** W1.https://presiuniv.knimbus.com/user#/home W2.https://www.javatpoint.com/ai-knowledge-engineering.
	Topics relevant to "SKILL DEVELOPMENT": Converting from English to Predicate Logic, and logically prove statements using inference rules like first-order resolution, Uncertain Reasoning and Expert Systems for skill development through participative learning techniques. This is attained through the assessment components mentioned in the course handout.

Course Code: AIE4001
Course Title: Artificial Intelligence
Type of Course: Program Core (Integrated Theory and Laboratory)
L-T-P-C: 2-0-2-3
Total Hours: 30 Hours Theory + 30 Hours Lab = 60 Hours
Version No.: 1.0
Course Prerequisites: Nil

Course Description:
This course introduces students to the fundamental principles and techniques of Artificial Intelligence (AI). It covers problem-solving, knowledge representation, reasoning, and learning. Students will implement AI algorithms and apply them to various domains through practical lab experiments.

Course Objectives:

- Understand the core concepts of Artificial Intelligence and intelligent agents.
- Analyze and implement search strategies for problem-solving.
- Learn knowledge representation schemes and reasoning techniques.
- Apply AI techniques in practical, real-world applications.

Course Outcomes (COs):

- **CO1:** Analyze the foundational principles and scope of Artificial Intelligence.
- **CO2:** Analyze and compare search algorithms for AI-based problem-solving.
- **CO3:** Apply knowledge representation and inference techniques.
- **CO4:** Apply AI algorithms to real-world scenarios using programming.

Course Content (Total: 60 Hours)

Module 1: Introduction to AI and Intelligent Agents (CO1 – Analyze) – 8 Theory Hours
Topics: History and evolution of AI, foundations and applications, AI techniques, Types of AI, Intelligent agents, environments, and agent structures.

Module 2: Problem Solving and Search (CO2 – Analyze) – 10 Theory Hours
Topics: Problem formulation, uninformed search (BFS, DFS, DLS, IDS), informed search (Greedy, A*), heuristic functions, constraint satisfaction problems.

Module 3: Knowledge Representation and Reasoning (CO3 – Apply) – 6 Theory Hours
Topics: Propositional and predicate logic, inference rules, semantic networks, frames, production rules, forward and backward chaining.

Module 4: AI Applications and Learning (CO4 – Apply) – 6 Theory Hours
Topics: Machine learning overview, rule-based systems, AI in NLP, robotics, computer vision, and expert systems.

Laboratory Experiments (15 Weeks / 30 Hours)

1. Implement intelligent agent simulation using Python.
2. Write a program to solve a problem using BFS and DFS.
3. Implement A* algorithm for a route-finding problem.
4. Solve a constraint satisfaction problem (e.g., Sudoku).
5. Develop a knowledge base using propositional logic.
6. Implement forward chaining inference.
7. Implement backward chaining inference.
8. Simulate a rule-based expert system.
9. Create a semantic network for a given domain.
10. Build a chatbot using basic NLP libraries.
11. Image recognition using pre-trained models.

12. Build a simple AI game (e.g., Tic-Tac-Toe).
13. Implement decision tree classification.
14. Develop a face detection system using OpenCV.
15. Final integration of an AI-based mini project.

Textbooks:

- **T1:** Stuart Russell & Peter Norvig, *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson Education.
- **T2:** Elaine Rich, Kevin Knight, Shivashankar B Nair, *Artificial Intelligence*, McGraw Hill Education.

Reference Books:

- **R1:** George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, Pearson Education.
- **R2:** Nils J. Nilsson, *The Quest for Artificial Intelligence*, Cambridge University Press.

Web Resources:

- [W1] https://www.csail.mit.edu/research/artificial-intelligence
- [W2] https://www.geeksforgeeks.org/artificial-intelligence/
- [W3] https://www.coursera.org/specializations/artificial-intelligence

Course Code: AIE4002	**Course Title: Machine Learning Algorithms** **Type of Course: Program Core** **Theory and Laboratory Integrated**	**L-T-P-C**	2	0	2	3
Version No.	2.0					
Course Pre-requisites	--					
Anti-requisites	NIL					
Course Description	This course provides a broad introduction to machine learning and statistical pattern recognition. Topics include: supervised learning (generative/discriminative learning, parametric/non-parametric learning, neural networks, support vector machines); unsupervised learning (clustering, dimensionality reduction, kernel methods); learning theory (bias/variance tradeoffs, practical advice); reinforcement learning and adaptive control.					
Course Objective	The objective of the course is to familiarize the learners with the concepts of Machine Learning Algorithms and attain **Skill Development** through **Experiential Learning** techniques.					
Course Out Comes	On successful completion of the course the students shall be able to: CO1: Identify the characteristics of datasets and compare the trivial data for various applications. CO2: Understand and apply scaling up machine learning techniques. CO3: To design and implement various machine learning algorithms in a range of real-world applications.					

Course Content:						
Module 1		Machine Learning Model Fundamentals	Assignment	Programming		**10 Sessions**
	Topics: Data-generating process, Understanding the structure and properties of good datasets, Scaling datasets, including scalar and robust scaling, Selecting training, validation and test sets, including cross-validation, Features of a machine learning model, Learnability, Capacity, including Vapnik-Chervonenkis theory, Bias including underfitting, Variance including overfitting, Regularization with types, cross validation, Defining loss and cost functions.					
Module 2		Clustering and Unsupervised Models	Assignment	Programming		**10 Sessions**
	Topics: K-Nearest Neighbors(KNN), based on k-dimensional(k-d) trees and ball tress, K-means and K-means++, Clustering Fundamentals, Evaluation of clustering models on the ground truth, Hierarchical clustering algorithms, Spectral clustering, DBSCAN, Clustering as a Mixture of Gaussians.					
Module 3		Semi- Supervised Learning Algorithms	Assignment	Programming		**15 Sessions**
	Topics: Introduction to Semi- Supervised Learning, Semi-supervised scenario, The different approaches to semi-supervised learning, Generative Gaussian Mixture, contrastive pessimistic likelihood estimation approach, Self-Training, Co-Training, Advanced Semi-Supervised Classification, Contrastive Pessimistic Likelihood Estimation(CPLE), Semi-supervised Support Vector Machines(S3VM). Transductive Learning via regularized least squares					
Module 4		Graph-Based Semi-Supervised Learning	Assignment	Programming		**12 Sessions**
	Topics: Graph-Based Semi-Supervised Learning, Label propagation, Example of label propagation, Label spreading, Label propagation based on Markov random walks, Manifold Learning. Quadratic cost criterio. Regularization with graph.					
	List of Laboratory Tasks: **Experiment N0 1:** Programming assignment for data cleaning.. **Level 1:** Programming scenarios which handles missing features, data normalization, data scaling. **Level 2:** Programming assignment which helps in feature filtering, selection. **Experiment No. 2:** Programming assignment for unsupervised learning **Level 1:** Implementation of covariance rule. Implementationof rubner_tavan_network **Level 2:** Implementation of sanger_network. **Experiment No. 3:** Programming assignment for advanced unsupervised learning					

	Level 1: Implementation of kNN, K-means. Implementation of fuzzy cmeans. **Level 2:** Implementation of spectral clustering. **Experiment No. 4:** Programming assignment for supervised learning. **Level 1**: Programming assignment on label_propogation, spreading **Experiment No. 5:** Programming assignment for supervised learning. **Level 1**: Implementing SVM **Level 2:** Implementing TSVM **Experiment No. 6:** Programming assignment for Graph-Based Supervised learning. **Level 1:** Estimating Gaussian mixture in ICA **Level 2:** Estimating parameter using PCA.
	Targeted Application & Tools that can be used: • Data Mining • Text Mining • Web Mining • Medical Industry **Tools**: Anaconda for Python or Google Colab for Python.
	Project work/Assignment: Mention the Type of Project /Assignment proposed for this course
	After completion of each module a programming-based Assignment/Assessment will be conducted. **A dataset will be given to the student to practice the learned algorithms** **On completion of Module 4, student will be asked to develop a Project for analyzing the given dataset.**
	Text Book **T1. Giuseppe Bonaccorso, *"Mastering Machine Learing Algorithms"*,Packt.** **T2. Giuseppe Bonaccorso, *"Machine Learning Algorithms"*,Packt.**
	References **R1. Imran Ahmed, *"40 Algorithms Every Programmer Should Know",* Packt** **Weblinks** W1.https://presiuniv.knimbus.com/user#/home W2.https://www.javatpoint.com/machine-learning-algorithms
	Topics relevant to "SKILL DEVELOPMENT: Machine Learning, Clustering and Unsupervised, Graph-Based Semi-Supervised Learning for developing Skill Development through Experiential Learning techniques. This is attained through assessment component mentioned in course handout

Course Code: AIE 4003	**Course Title: Deep Learning** **Type of Course: Program Core Theory and Laboratory Integrated**	**L-T-P-C**	2	0	2	3

Version No.		2.0
Course Pre-requisites	•	--
Anti-requisites		NIL
Course Description		The course introduces the core intuitions behind Deep Learning, an advanced branch of Machine Learning involved in the development and application of Artificial Neural Networks that function by simulating the working principle of human brain. Deep learning algorithms extract layered high-level representations of data in a way that maximizes performance on a given task. The course includes theory and lab components which emphasizes on understanding the implementation and application of deep neural networks in various prominent problem domains like speech recognition, sentiment analysis, recommendations, and computer vision etc. The course facilitates the students to interpret and appreciate the successful application of deep neural nets in various prediction and classification tasks of ML.
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Deep Learning** and attain **SKILL DEVELOPMENT** through **Experiential Learning techniques**
Course Out Comes		On successful completion of the course the students shall be able to: CO1: Apply basic concepts of Deep Learning to develop feed forward models CO2: Apply Supervised and Unsupervised Deep Learning techniques to build effective models for prediction or classification tasks CO3: Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains of Machine Learning and Machine vision. CO4: Analyze performance of implemented Deep Neural models
Course Content:		

Module 1	Introduction to Deep Learning	Assignment	Programming		**10 Sessions**
	Topics: Machine Learning in a nutshell, Fundamentals of deep learning and neural networks, Deep Neural Network, Feedforward Neural Network, Perceptron, Activation Functions, Loss Functions, Gradient Descent, Back-propagation, Training Neural Networks Building your Deep Neural Network: Step by Step, Introduction to CNN				

Module 2	Improving Deep Neural Networks	Assignment	Programming		**09 Sessions**
	Topics: Hyperparameter tuning, Initialization, Overfitting and Underfitting, Regularization and Optimization, Dropout, Batch Normalization				
Module 3	Deep Supervised Learning Models	Assignment	Programming		**10 Sessions**
	Topics: Convolutional neural network with pooling flattening, Prediction of image using Convolutional Neural Networks, Deep learning in Sequential Data, RNN & LSTM, GRU,				
Module 4	Deep Unsupervised Learning	Assignment	Programming		**10 Sessions**
	Topics: Basics of Deep unsupervised learning, Auto encoders, Recommender systems, computer vision				
	List of Laboratory Tasks: **Experiment No. 1:** Programming assignment to implement a single layer feed forward neural network from scratch (Application: A basic neural network). **Level 1:** Programming scenario to implement a basic single layer feed-forward neural network perceptron. **Level 2:** Programming scenario to implement a basic single layer feed-forward neural network with a single hidden layer having ReLU activation function and sigmoid in the output layer. **Experiment No. 2:** Programming assignment to build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets. **Level 1:** Programming scenario to use the Backpropagation algorithm to build an ANN and run it on a dataset for few epochs. **Level 2:** Programming scenario to use the Backpropagation algorithm to build an ANN and run it on a dataset for few epochs and interpret the accuracy, loss and other evaluation parameters. **Experiment No. 3:** Programming assignment to build a multiple layer neural network with specific model parameters and hyperparameters on a given real life dataset. **Level 1:** Programming assignment to implement a MLP with ○ possibility to use 2-4 layers				

- ReLU for the hidden layer
- Sigmoid in the output layer
- optimization via gradient descent (GD)

Level 2: Programming assignment to implement the neural network and add some more hyperparameters in the perceptron model

- softmax output layer
- optimization via stochastic gradient descent (SGD)
- Gradient checking code (!!!)

Generate the confusion matrix

Experiment No. 4: Programming assignment to implement classification of linearly separable Data with a Deep neural network (Application: Binary classification).

Level 1: Programming scenarios to build a binary classifier with a deep ANN.

Level 2: Programming scenarios to build a binary classifier with a deep ANN

- Weight initialization with random noise (!!!) (use normal distribution with changing std. deviation for now)
- implement dropout, *l2* regularization
- implement a different optimization scheme (RPROP, RMSPROP, ADAGRAD)
- employ batch normalization

Experiment No. 5: Programming assignment to implement a basic Convolution Neural Network.

Level 1: Programming scenarios which use the concept of convolution and pooling to implement a CNN.

Level 2: Programming scenarios which use the concept of convolution and pooling to implement a CNN and also specify some parameters like number of filters, length of feature detector, stride etc.

Experiment No. 6: Programming assignment to perform image segmentation and object detection using CNNs.

Level 1: Programming assignment to instantiate a CNN (that uses FullyConnectedLayers) and train the neural network using the training data from MNIST data set.

Level 2: Programming assignment to instantiate a CNN (that uses FullyConnectedLayers) and train the neural network using the training data from MNIST data set. Choose appropriate hyper parameters for the training of the neural network. Plot the cost versus training iterations using different mini-batch sizes: 16; 64; 256; 1024. Record the test accuracy in percentage and total training time you spent in seconds. Implement Adam Optimizer. To obtain full marks, the network should be able to achieve a test accuracy of 90% or more across many different random seeds.

Experiment No. 7: Programming assignment to employ CNN in image classification from given dataset.

Level 1: Programming scenario to instantiate a CNN (with at least one convolutional layer) and train the neural network using the training data from CIFAR10 data. Choose appropriate hyperparameters for the training of the neural network. The network should be able to achieve a test accuracy of at least 50% within 10 training epochs.

Level 2: Programming scenario to build a CNN (with more than one convolutional layer) and train the neural network using the training data from CIFAR10 data. Choose appropriate hyperparameters for the training of the neural network. The network should be able to achieve a test accuracy of at least 50% within 10 training epochs. Continue to train further and examine training and testing performance. Report hyperparameters (learning rate, number of hidden layers, number of nodes in each hidden layer, batch size and number of epochs) of the Deep Neural Network. Also, explain the observations.

Experiment No. 8: Programming assignment to perform Sentence (text) Classification using Convolutional Neural Networks.

Level 1: Programming Scenarios to utilize CNN to categorize text data in given datasets like SST movie reviews.

Level 2: Programming Scenarios to utilize CNN to categorize text data in given datasets like SST and MR movie reviews.

Experiment No. 9: Programming assignment to apply Recurrent Neural Networks for sentiment analysis of text data.

Level 1: Programming scenario to build a model to perform sentiment analysis of IMDB movie reviews using. Reviews are categorized into two polarities: positive and negative.

Level 2: Programming scenario to build a model to perform sentiment analysis of IMDB movie reviews. Reviews are categorized into three polarities: positive, negative and neutral.

Experiment No. 10: Programming assignment to create a generative model for text, character-by-character using Recurrent neural networks.

Level 1: Programming scenario to implement a multi-layer Recurrent Neural Network like LSTM for training/sampling from character-level language models, which takes one text file as input and trains an RNN that learns to predict the next character in a sequence. The RNN can then be used to generate text character by character that will look like the original training data.

Level 2: Programming scenario to implement a multi-layer Recurrent Neural Network utilizing both LSTM and GRU in turns for training/sampling from character-level language models, which takes one text file as input and trains an RNN that learns to predict the next

	character in a sequence. The RNN can then be used to generate text character by character that will look like the original training data. Train the model and use it to generate new text. **Experiment No. 11:** Programming assignment to implement RNN models for multivariate time series forecasting. **Level 1:** Programming scenario to implement a many-to-one Recurrent Neural Network for Stock Price forecasting, i.e. trained with a certain number of day's data, the model should predict the stock price of the next day. **Level 2:** Programming scenario to implement a many-to-one Recurrent Neural Network for Stock Price forecasting, i.e. trained with a certain number of day's data, the model should predict the stock price of the next day. Students are free to use RNN, GRU, or LSTM (or compare between) and any number of layers and architecture. In the testing, plot the ground truth and your predicted values for 100 days. **Experiment No. 12:** Programming assignment to implement Autoencoders and deep Boltzmann's machines. **Level 1:** Programming scenario to implement a basic recommender system using deep Boltzmann's machines. **Level 2:** Programming scenario to build a recommender system with Collaborative filtering algorithm using deep Boltzmann's machines,
	Targeted Application & Tools that can be used: Targeted employment sector is not restricted to any single domain. Today, ML and Dl have been employed for data analysis and improved business intelligence in every sector. Targeted job profiles include Data Analyst, Data Scientist, Data Engineer, Neuroinformatician, Bioinformatician, Image Recognition, Research Analyst, Full Stack Developer for Deep Learning, Natural Language Process Engineer, Business Analyst etc. Few of the top recruiters are Amazon, NVIDIA. Microsoft, IBM, Accenture, Facebook, Intel, Samsung, Lenovo, Adobe etc., among numerous others. **Tools**: Neural Designer, AutoML, AutoDL, Keras, TensorFlow, Torch, Google Colaboratory, Spider, Jupiter Notebook
	Project work/Assignment:
	Throughout the progression in each module, students will have to submit scenario based programming Assignments/Experiments as listed in "List of Lab Tasks". On completion of each module, students will be asked to develop a Mini Project, similar to the following: • **Music genre classification system** This is one of the interesting deep learning project ideas. This is an excellent project to nurture and improve one's deep learning skills. The aim is to create a deep learning model that uses neural networks to classify the genre of music automatically. For this project, students will use an FMA (Free Music Archive)

dataset. FMA is an interactive library comprising high-quality and legal audio downloads. It is an open-source and easily accessible dataset.
However, it is noteworthy that before one can use the model to classify audio files by genre, he/she will have to extract the relevant information from the audio samples (like spectrograms, MFCC, etc.)

- **Image Caption generator**
  This is one of the trending deep learning project ideas. This is a Python-based deep learning project that leverages Convolutional Neural Networks and LTSM (a type of Recurrent Neural Network) to build a deep learning model that can generate captions for an image. An Image caption generator combines both computer vision and natural language processing techniques to analyze and identify the context of an image and describe them accordingly in natural human languages (for example, English, Spanish, Danish, etc.). This project will strengthen one's knowledge of CNN and LSTM, and one will learn how to implement them in real-world applications as this.

- **Visual tracking system**
  A visual tracking system is designed to track and locate moving object(s) in a given time frame via a camera. It is a handy tool that has numerous applications such as security and surveillance, medical imaging, augmented reality, traffic control, video editing and communication, and human-computer interaction. This system uses a deep learning algorithm to analyze sequential video frames, after which it tracks the movement of target objects between the frames. The two core components of this visual tracking system are Target representation and localization

- **Traffic Signal Classification**
  The traffic sign classification project is useful for all autonomous vehicles. Machines are able to identify traffic signs from the image. Students can use the GTSRB dataset that contains 43 different traffic sign classes. This is a good project to understand image classification.

- **Driver Drowsiness Detection**
  The driver drowsiness detection is a project which can detect whether a person is sleeping or not while driving. We can implement a model for drivers and it can also prevent accidents from happening.

- **Autocolouring old Black and white images**
  The idea of this project is to make a model that is capable of colorizing old black and white images to colorful images. Digital artists take a few hours to color the image but now with Deep Learning, it is possible to color an image within seconds.

Text Book

	T1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017
	References R1. Duda, R.O., Hart, P.E., and Stork, D.G. Pattern Classification. Wiley-Inderscience, 2nd Edition. 2013 R2. Theodoridis, S. and Koutroumbas, K. Pattern Recognition. Edition 4, Academic Press, 2015 R3. Russell, S. and Norvig, N. Artificial Intelligence: A Modern Approach. Prentice Hall Series in Artificial Intelligence, 2013 R4. Bishop, C. M. Neural Networks for Pattern Recognition, Oxford University Press, 2008. **Weblinks** W1.https://presiuniv.knimbus.com/user#/home W2.https://www.ibm.com/in-en/topics/deep-learning#:~:text=Deep%20learning%20is%20a%20subset,from%20large%20amounts%20of%20data.
	Topics relevant to development of "SKILL DEVELOPMENT": Real time Data Analysis using Deep learning. for developing **SKILL DEVELOPMENT** through **Experiential Learning** techniques. This is attained through assessment component mentioned in course handout

Course Code: AIE5404	**Course Title: Natural Language Processing** **Type of Course: Program Core** **Theory and Laboratory Integrated Course**	**L-T-P- C**	2	0	2	3

Version No.		2.0
Course Pre-requisites		--
Anti-requisites		**NIL**
Course Description		This course introduces a basics of Natural Language Processing methods with specific emphasis on modern applications. The course will cover pre-processing techniques of textual data like stemming, lemmatization, tokenization etc. Different word Vectorization Techniques like Bag of Words, TF-iDF etc. followed by basics of Probability for building language models. Basics of Neural Network, LSTM Recurrent Neural Network, Applications of NLP like Information Extraction, Emotion Extraction from text, sentiment analysis etc.
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Natural Language Processing** and attain **SKILL DEVELOPMENT** through **Experiential Learning** techniques
Course Outcomes		**On successful completion of this course the students shall be able to:** CO1: Understanding the fundamentals of NLP techniques. CO2: Apply Language modelling techniques for predictions. CO3: Apply Deep learning Techniques to build NLP Model

		CO4: Outline the application of NLP Techniques.			
Course Content:					
Module 1	**pre-processing techniques**	Assignment		**Apply all the pre-processing techniques to the corpus of your choice.**	**14 Sessions**
	Topics: Introduction to Natural Language Processing, terminologies, empirical rules, why NLP is hard, why NLP is useful, Natural Language generation, NLP Processing pipeline, Corpus Cleaning techniques – word tokenization, sentence tokenization, word frequency distribution, stemming, lemmatization, dictionary, Part of Speech Tagging, optical character recognition, Textual Pre-Processing techniques – Stop words removal, regular expression, lower case, text standardization. Punctuation Mark Removal.				
Module 2	**Language Model**	**Assignment**		**Build n-gram language model for future word predictions.**	**11 Sessions**
	Topics: Word Embeddings techniques- bag of words, Tf-iDF, Word2Vec and optimization. Hidden Markov Models Simple N-gram models. Estimating parameters and smoothing. Negative Sampling Evaluating language models. (Forward and Viterbi algorithms and EM training), Maximum Entropy Models, N-gram and unigram.				
Module 3	**Deep Learning techniques for NLP models**	**Assignment**		**Build model for spam detection using mail subject as Corpus**	**11 Sessions**
	Topics: **Introduction to Neural Network, Perceptron, back Propa**gation, Recurrent Neural network, LSTM, Attention Models, BERT (Bidirectional **E**ncoder **R**epresentation from **T**ransformer), Reformer, speech recognition. Document summarization				
Module 4	**Application of NLP**	**Assignment**		**Paper Review of State-of-the-ArtNLP Technique**	**11 Sessions**
	Topics: Application of NLP- Lexical semantics and word-sense disambiguation. Named entity recognition and relation extraction. IE using sequence labeling, Emotion Extraction. tExt Summarization**.**				
	Targeted Application & Tools that can be used:				

	1. **Application Area Sentiment Analysis , Text Classification , Chatbots & Virtual Assistants , Text Extraction , Machine Translation , Text Summarization , Market Intelligence , Auto-Correct , Intent Classification , Urgency Detection , Speech Recognition** **Professionally Used Software: Anaconda Navigator, Python Packages, NLP toolkit** **List of Laboratory Task** 1. **Experiment No. 1: Apply all preprocessing technique to corpus of choice and plot word frequency.** 2. **Experiment No. 2: Word Embedding using Bag of words** 3. **Experiment No. 3: Word Embedding using TF-iDF** 4. **Experiment No. 4: Word Embedding using Word2Vec Continuous Bag of words** 5. **Experiment No. 5: Word Embedding using Word2Vec Skip gram Model** 6. **Experiment No. 6: Build language Model using n- gram.** 7. **Experiment No. 7: Build NLP model using LSTM** 8. **Experiment No. 8: Build NLP model using BERT** 9. **Experiment No. 9: Build NLP model using Reformer to show optimization.**
	Project work/Assignment:
	Project Assignment: NIL **Assignment 1: Paper Review of the state of the art NLP Technique**
	Text Books T1. Daniel Jurafsky, James H. MartinSpeech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014. T2. Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Pythonll, First Edition, OReilly Media, 2009.
	References **R1. Breck Baldwin, Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.** **R2. Richard M Reese, Natural Language Processing with Javall, OReilly Media, 2015.** **R3. Nitin Indurkhya and Fred J. Damerau, Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.** **R4. Tanveer Siddiqui, U.S. Tiwary, Natural Language Processing and Information Retrieval, Oxford University Press, 2008.** **Weblinks** W1.https://presiuniv.knimbus.com/user#/home W2.https://www.ibm.com/in-en/topics/natural-language-processing

	Topics relevant to development of "SKILL DEVELOPMENT": Information retrieval of Search Engines Information Retrieval. for developing **SKILL DEVELOPMENT** through **Experiential Learning techniques**. This is attained through assessment component mentioned in course handout.

Course Code: AIE4011	**Course Title: Robotic Process Automation** **Type of Course: Discipline Elective** **Theory only**	**L- T-P-C**	3	0	0	3

Version No.		2.0
Course Pre-requisites		--
Anti-requisites		**NIL**
Course Description		The purpose of this course is to enable the students to appreciate the need for Robotic Process Automation and the course offers comprehensive knowledge and professional-level skills focused on developing and deploying software robots using UiPath Platforms. The course is both conceptual and Practical in nature and needs basic knowledge of Computer Programming. The course assumes no prior knowledge of RPA. It begins by refreshing basic programming skills and introducing basic RPA concepts. The course develops skills to identify task which can be automated and develop it with UiPath Studio. The course also enhances the programming abilities through assignments.
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Robotic Process Automation** and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING techniques
Course Outcomes		On successful completion of the course, the students shall be able to: CO1.Explain the concept of automation. CO2.Describe various programming constructs in RPA. CO3.Identify and understand different simulation drive robots. CO4.Apply automation to various concepts related to AI and ML algorithms.
Course Content:		

Module 1	Introduction to Programming Concepts and RPA Basics	Assignment	Data Analysis		**10 Sessions**
	Topics: **Programming Concepts Basics-1**: Software applications, Introduction to Programming, Data and data structure, Algorithms, Sequence, and Flow, and Software Development Guidelines. **Programming Concepts Basics-2:** Compiler and execution, Scripting and Macro, Frameworks and Languages, Information Sharing Mechanism, Variables and Arguments, Files and File Types, Access				

	Control. **RPA Basics:** Automation and RPA, Programming Constructs in RPA, Robots in RPA, RPA in Business and Technology.					
Module 2	RPA Advanced Concepts	Assignment	Build own bots			**10 Sessions**
	Topics: **RPA Advanced Concepts:** Setting up the Center of Excellence, RPA Project Methodology, The RPA Journey, RPA in the Emerging Ecosystem. **Introduction to UiPath:** The Basics of UiPath Studio Installation, The User Interface, the various steps involved in the automation projects, The installation of UiPath extensions. **Variables:** Variables, Types of Variables, Variables in UiPath, Arguments, Namespaces. **Control Flow:** Control Flow & Universal Statements, Control Flow Statements in UiPath, Practical Exercise					
Module 3	Simulation of differential drive robots	Assignment	Differential robots			**10 Sessions**
	Introduction to Gazebo, Installation, Testing Gazebo with ROS interface, Simulation of differential drive robot using ROS technical requirements: Getting Started with Gazebo Simulator, Working with TurtleBot2 simulation, Creating a simulation of Chefbot.					
Module 4	Advanced Automation and Orchestrator	Case Study	Data Collection and Team Project			**10 Sessions**
	Topics: **Email Automation:** Introduction to Email Automation, Email Automation in UiPath Studio, Practice retrieving and sending emails **Debugging and Exception Handling:** Exception Handling, Debugging Tools, Workflow Designs, Catching errors **Project Organization:** Project Organization, Process, Library, Robotic Enterprise Framework **Orchestrator:** Introduction to Orchestrator, Processes, Robots in Orchestrator, Working with Orchestrator **Future Trends:** Artificial Intelligence, Autonomous things, Digital Assistant, Computing					
	Targeted Application & Tools that can be used: Targeted employment sector is service provider and control monitor like GE, Siemens, TCS etc. Targeted job profiles include digital domain and Service based indusrty etc. **Tools:** • UiPath Studio/StudioX					
	Project work:					
	Project 1: Sales order entry Robot **Project 2: E-Mail auto responder Robot** **Project 3: Disk Monitoring Robot**					
	Text Book T1. "Robotic Process Automation using UiPath StudioX", Adeel Javed, Anum Sundrani, Nadia Malik, Sidney Madison Prescott, Apress, 2021					

	References R1. "Learning Robotic Process Automation", Alok Mani Tripathi, Packetz, 2018. R2. https:// academy.uipath.com/ **Weblinks** W1.https://presiuniv.knimbus.com/user#/home W2.https://www.geeksforgeeks.org/robotics-introduction/.
	Topics relevant to development of "EMPLOYABILITY SKILLS": Get introduced to RPA Studio and RPA developer Tools for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: AIE4012	**Course Title:** Machine Vision **Type of Course:** Discipline Elective Theory Only	**L-T-P- C**	3	0	0	3
Version No.		1.0				
Course Pre-requisites		--				
Anti-requisites		**NIL**				
Course Description		This course provides an introduction to computer vision including fundamentals of image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, image classification and scene understanding. We'll explore methods for depth recovery from stereo images, camera calibration, automated alignment, tracking, boundary detection, and recognition. We'll use both classical machine learning and deep learning to approach these problems. The focus of the course is to develop the intuitions and mathematics of the methods in lecture, and then to learn about the difference between theory and practice in the projects.				
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Machine Vision** and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING techniques				
Course Outcomes		On successful completion of the course the students shall be able to: 1. Describe Image formation and Camera Models [Knowledge] 2. Classify techniques for Local feature extraction and tracking [Comprehension] 3. Apply the different category of calibration methods and dimension reconstruction approach for computer vision[Application]				
Course Content:						

Module 1	Basic Concept of Image Processing	Mini Project	Mapping Facial Features		**12 Classes**
	Introduction to Image Processing-Basic mathematical concepts: Image enhancement: Grey level transforms, Spatial filtering. Extraction of special features: edge and corner detection. Morphological processing, Image transforms, Discrete Fourier Transform, Fast Fourier Transform. Frequency domain enhancement.				
Module 2	Image Segmentation	Mini Project	Hand gesture recognition		**14 Classes**
	Image Segmentation Algorithms: contextual, non-contextual segmentation, texture segmentation. Feature Detectors and Descriptors, Feature Matching-Object Recognition, The Use of Motion in Segmentation Optical Flow & Tracking Algorithms, Face detection (Viola Jones), Face Recognition.				
Module 3	Image Dimensions	Mini Project	Surveillance		**14 Classes**
	2D and 3D feature-based alignment, Pose estimation, Geometric intrinsic calibration, - Camera Models and Calibration: Camera Projection Models – orthographic, affine, perspective, projective models. Projective Geometry, transformation of 2D and 3D, Internal Parameters, Lens Distortion Models, Calibration Methods – linear, direct, indirect and multi plane methods. Visual servo. Stereo correspondence-Epipolar geometry, Fundamental matrix, Introduction to SLAM (Simultaneous Localization and Mapping).				
	Targeted Application & Tools that can be used: Computer Vision applications are **used for traffic sign detection, surveillance and recognition**. Vision techniques are applied to segment traffic signs from different traffic scenes (using image segmentation) and algorithms to recognize and classify traffic signs. **Tools:** • MAT Lab/Open CV				
	Project work/Assignment:				
	Project Work: **1. Detect the faces of humans by mapping facial features from a video or an image. There are several steps involved in these projects, such as mapping features.** **2. Hand gesture recognition is one of the critical topics for human-computer interaction. In this project, there are several tasks which are needed to be performed. This includes the hand region, which is to be extracted from the background, followed by segmenting the palms and fingers to detect finger movements.** **3. Count the number of people passing through a specific scene. The applications of this project include civilian surveillance, pedestrian tracking, pedestrian counting, etc.** **4. Design, implement and test on several regions on a set of images based on the segmentation algorithms.**				
	Text Book 1. R. C. Gonzalez, R. E. Woods, 'Digital Image Processing', Pearson,2017				

	2. Introduction to Computer Vision and its Application, Richard Szelinski,2021
	References 1 . Emanuele Trucco and Alessandro Verri, "*Introductory Techniques for 3-D Computer Vision*", Prentice Hall, 1998. 2 Olivier Faugeras, "*Three Dimensional Computer Vision*", MIT Press, 1993. 3 Richard Szeliski, "*Computer Vision: Algorithms and Applications*", Springer, 2011. 4 Milan Sonka, Vaclav Hlavac and Roger Boyle, "*Image Processing, Analysis and Machine Vision*", Third Edition, CL Engineering, 2013. 5.Marco Treiber, "An Introduction to Object Recognition Selected Algorithms for a Wide Variety of Applications", Springer, 2010. 6.Forsyth and Ponce, "Computer Vision – A Modern Approach", Second Edition, Prentice Hall, 2011.
	Topics relevant to development of " EMPLOYABILITY SKILLS ", " IMAGE SEGEMENTATION and DIMENSIONS of Image Processing- We compare IMAGE PROCESSING/ COMPUTER VISION jobs with Information Technology service oriented jobs then obviously there is relatively limited scope. But things are changing very fast as time is changing. Scope of image processing/computer vision jobs is increasing day to day.

Course Code: AIE4013
Course Title: Cloud Computing
Type of Course: Program Core
L-T-P-C: 3-0-0-3
Total Hours: 45 Hours
Version No.: 1.0
Course Prerequisites: Nil
Anti-requisites: —

Course Description:
This course provides a comprehensive introduction to cloud computing, exploring the foundations, service models, deployment models, and key technologies. It includes discussion on virtualization, resource provisioning, cloud security, storage, and recent trends in cloud services. Students will also understand the impact and applications of cloud computing in modern IT infrastructure.

Course Objectives:

- Understand the key concepts and architecture of cloud computing.
- Explore various service and deployment models in cloud environments.
- Analyze virtualization and resource management in cloud platforms.
- Discuss issues related to cloud security, privacy, and performance.
- Evaluate different cloud platforms and services.

Course Outcomes (COs):

- **CO1 (Understand):** Describe fundamental concepts, architecture, and benefits of cloud computing.
- **CO2 (Analyze):** Compare cloud service models and deployment approaches.
- **CO3 (Apply):** Illustrate virtualization and resource provisioning techniques.

- **CO4 (Analyze):** Examine cloud security concerns and evaluate real-world cloud platforms.

Course Content (Total: 45 Hours)

Module 1: Introduction to Cloud Computing (CO1 – Understand) – 11 Hours
Topics: Cloud characteristics, benefits and challenges, cloud architecture, evolution of cloud computing, cloud vs. traditional computing, NIST definition, role of networks in cloud computing.

Module 2: Cloud Service and Deployment Models (CO2 – Analyze) – 11 Hours
Topics: IaaS, PaaS, SaaS – examples and use cases, public, private, hybrid, and community clouds, economics and ROI of cloud computing, service level agreements (SLAs).

Module 3: Virtualization and Resource Management (CO3 – Apply) – 11 Hours
Topics: Virtualization techniques, hypervisors (VMware, KVM, Xen), virtual machine provisioning and migration, load balancing, autoscaling, containers and Docker.

Module 4: Cloud Security and Emerging Trends (CO4 – Analyze) – 12 Hours
Topics: Security and privacy issues, identity and access management, compliance standards (ISO, GDPR), multi-tenancy, cloud storage systems, introduction to edge computing and serverless computing, overview of AWS, Azure, and GCP.

Textbooks:

- **T1:** Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi, *Mastering Cloud Computing*, McGraw-Hill, 2013.
- **T2:** Toby Velte, Anthony Velte, and Robert Elsenpeter, *Cloud Computing: A Practical Approach*, McGraw-Hill, 2010.

Reference Books:

- R1: Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, *Cloud Computing: Concepts, Technology & Architecture*, Pearson Education.
- R2: George Reese, *Cloud Application Architectures*, O'Reilly Media.

Web Resources:

- [W1] https://aws.amazon.com/
- [W2] https://cloud.google.com/
- [W3] https://azure.microsoft.com/
- [W4] https://www.ibm.com/cloud

Course Code: AIE 4014	**Course Title:** Ontology Engineering for the Semantic Web **Type of Course:** Discipline Elective **Theory Only**	**L- T-P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	--					
Anti-requisites	**NIL**					

Course Description		This course presents the basics of semantic web and Ontology engineering. This course consist of the detailed description RDF frameworks. This course is designed with theoretical material on ontology design, Description Logics, and developing ontologies using OWL. The course uses the Protege-OWL environment.
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Ontology Engineering for the Semantic Web** and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING techniques
Course Outcomes		On successful completion of the course the students shall be able to: CO1. Understand the semantic web basics, architecture and technologies. CO2. Describe the semantic relationships among the data elements using Resource Description Framework (RDF) CO3. Analyze the conventional web with semantic web. CO4. Able to design and implement real-world applications that "discovers" the data and/or other web services via the semantic web
Course Content:		

Module 1	Introduction	Assignment	Analysis, Data Collection		**9 Sessions**
	Topics: Introduction to the Syntactic web and Semantic Web, Evolution of the Web, The visual and syntactic web, Levels of Semantics, Metadata for web information, The semantic web architecture and technologies, A Layered Approach, Semantic Modeling -Potential of semantic web solutions and challenges of adoption.				
Module 2	Ontological Engineering	Assignment	Analysis, Data Collection		**9 Sessions**
	Topics: Ontologies, Taxonomies, Topic Maps, Classifying Ontologies, Terminological aspects: concepts, terms, relations between them, Complex Objects, Subclasses and Sub properties, definitions, Upper Ontologies, Quality, Uses, Types of terminological resources for ontology building, Methods and methodologies for building ontologies, Multilingual Ontologies, methods for Ontology Learning, Constructing Ontologies Manually, Reusing Existing Ontologies, Ontology Evolution, Versioning.				
Module 3	Describing the Web Resources	Assignment	Data analysis task		**9 Sessions**
	Topics: RDF Overview, The basic elements of RDF, RDF triples, Fundamental rules of RDF Aggregation and distributed information, RDF tools, RDF and RDF Schema in RDF Schema, RDFS, , Need for RDFS, Core elements of RDFS, RDF Schema: Basic Ideas.				
Module 4	Web Ontology Language and Real-world examples	Case Study	Analysis, Data Collection		**11 Sessions**
	Topics:				

	Requirements for Ontology Languages, OWL Sub languages, Description of the OWL Language, Layering of OWL, Examples for OWL, OWL in OWL, Future Extensions, Building Classes from Other Classes, Restricting Properties of Classes. SWOOGLE and FOAF: basics, architecture, usage and examples.
	Targeted Application & Tools that can be used: **Enterprise applications**. A more concrete example is SAPPHIRE (Health care) or Situational Awareness and Preparedness for Public Health Incidences and Reasoning Engines which is a semantics-based health information system capable of tracking and evaluating situations and occurrences that may affect public health. **Geographic information systems** bring together data from different sources and benefit therefore from ontological metadata which helps to connect the semantics of the data. **Domain-specific ontologies** are extremely important in biomedical research, which requires named entity disambiguation of various biomedical terms and abbreviations that have the same string of characters but represent different biomedical concepts. **Tools:** • **Protégé** • **Neon Toolkit** • **SWOOP** • **Vitro**
	Project work:
	Mini Project: • Ontology-Based Model for the "Ward-round" Process in Healthcare To design an ontology-based model that can fix information flow problems in the ward-round process of hospital unit. This can used to provide relevant information to the domain users according to their needs and demands. The domain users profiling and describes their roles, information demands with competencies: skills, qualifications and experiences. The ontology based model will be implemented in OWL language that can be used in an application to support ward-round activities for achieving effective patient's treatment process.
	Text Book/ 1. Grigoris Antoniou, Frank Van, "Semantic Web Primer", MIT Press, 2008 2. Karin K. Breitman, Marco Antonio Casanova and Walter Truszowski, "Semantic Web Concepts: Technologies and Applications", Springer, 2007 **References Books** 1. LiyangYu , "Introduction to the Semantic Web and Semantic web services" Chapman & Hall/CRC, Taylor & Francis group, 2007 2. Peter Mika, "Social networks and the Semantic Web", Springer, 1st edition 2007 3. Robert M. Colomb, "Ontology and the Semantic Web", Volume 156 ,Frontier in Artificial Intelligence and Applications, IOS Press, 2007 4. Michael C. Daconta, Leo J. Obrst, and Kevin T. Smith, "The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management", Fourth Edition, Wiley Publishing, 2003.

	Weblinks W1.https://presiuniv.knimbus.com/user#/home. W2. https://en.wikipedia.org/wiki/Ontology_engineering.
	Topics relevant to "ONTOLOGY ENGINEERING and " SEMANTIC WEB": Syntactic web and Semantic Web, Multilingual Ontologies, Ontology Development process and Life cycle, RDF triples, Fundamental rules of RDF Aggregation and distributed information, OWL Sub languages for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.

Course Code: AIE 4015	**Course Title: Intelligent Information Retrieval** **Type of Course: Discipline Elective** **Theory Only**	**L-T- P-C**	3	0	0	3

Version No.		2.0
Course Pre-requisites		CSE5005
Anti-requisites		**NIL**
Course Description		This Course studies the theory, design, implementation and evaluation of information retrieval systems. The focus is on the core concepts of Text- based information systems, statistical characteristics of text, representation of information needs and documents. Several important retrieval models, algorithms, and Recommender System. Also examined is how an effective information search and retrieval is interrelated with the organization and description of information to be retrieved. Throughout the course, current literature from the viewpoints of both research and practical retrieval technologies on the World Wide Web will be examined.
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Intelligent Information Retrieval** and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING techniques
Course Outcomes		On successful completion of the course the students shall be able to: CO1: Define basic concepts of information Retrieval and Recommender System CO2: Evaluate the effectiveness and efficiency of different information retrieval methods CO3: Explain the standard methods for Web indexing and retrieval CO4: Develop Methods for implementing a recommender system
Course Content:		

Module 1	INTRODUCTION	Assignment	Term Paper		**8 Sessions**
	Topics:				

	Information Retrieval – Early Developments – The IR Problem -Components of IR Model–User Interaction with IR model- The Users Task – Information versus Data Retrieval – The IR System – The Software Architecture of the IR System – The Retrieval and Ranking Processes – The Web – The e-Publishing Era – How the web changed Search – Practical Issues on the Web – How People Search.					
Module 2	MODELING AND RETRIEVAL EVALUATION	Assignment	Term Paper		**12 Sessions**	
	Topics: Basic IR Models – Boolean Model – TF-IDF (Term Frequency/Inverse Document Frequency) Weighting – Vector Model – Probabilistic Model – Latent Semantic Indexing Model – Neural Network Model –Set Theoretic-Fuzzy, Extended Boolean, Retrieval Evaluation – Retrieval Metrics – Precision and Recall – Reference Collection – User-based Evaluation.					
Module 3	WEB RETRIEVAL AND WEB CRAWLING	Assignment	Term Paper		**10 Sessions**	
	Topics: The Web – Search Engine Architectures – Cluster based Architecture – Distributed Architectures – Search Engine Ranking – Link based Ranking – Simple Ranking Functions – Learning to Rank – Evaluations — Search Engine Ranking – Search Engine User Interaction – Browsing – Applications of a Web Crawler – Taxonomy – Architecture and Implementation – Difference between web scraping and web crawling.					
Module 4	RECOMMENDER SYSTEM	Assignment	Term Paper		**10 Sessions**	
	Topics: Recommender Systems Functions – Data and Knowledge Sources – Recommendation Techniques – Basics of Content-based Recommender Systems – High-Level Architecture – Advantages and Drawbacks of Content-based Filtering – Collaborative Filtering – Matrix factorization models – Introduction to user-based recommender systems.					
	Targeted Application & Tools that can be used: • Information Retrieval Applications • Machine Learning Applications **Tools:** • Bow Toolkit • GATE • Lemur • MG • Smart (System for the Mechanical Analysis and Retrieval of Text) Information Retrieval System is an information retrieval system **developed at Cornell University** in the 1960s.					
	Text Book					

	T1.Ricardo Baeza-Yates and Berthier Ribeiro-Neto, —Modern Information Retrieval: The Concepts and Technology behind Search, Second Edition, ACM Press Books, 2011. Link: https://people.ischool.berkeley.edu/~hearst/irbook/ T2.Ricci, F, Rokach, L. Shapira, B.Kantor, —Recommender Systems Handbook, First Edition, 2011. T3.C. Manning, P. Raghavan, and H. Schütze, —Introduction to Information Retrieval, Cambridge University Press, 2008. Link: https://nlp.stanford.edu/IR-book/
	References R1.Mikhail Klassen, Matthew A. Russell, Mining the Social Web,O'Reilly Media, Inc., 3rd Edition (2019) R2.Stefan Buettcher, Charles L. A. Clarke and Gordon V. Cormack, —Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press, 2010. R3.Ceri, S., Bozzon, A., Brambilla, M., Della Valle, E., Fraternali, P. and Quarteroni, S., 2013. Web information retrieval. Springer Science & Business Media. **Weblinks** W1.https://presiuniv.knimbus.com/user#/home W2.https://www.geeksforgeeks.org/what-is-information-retrieval/.
	Topics relevant to development of "EMPLOYABILITY SKILLS": Software Development Engineer(Flipkart), Architect, Information Retrieval Officer, Research Scientist – IBM Research, Machine Learning Application Developer and Lead Engineer / Module Lead – Java / Python for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout

Course Code: AIE4016
Course Title: Internet of Things
Type of Course: Program Core
L-T-P-C: 3-0-0-3
Total Hours: 45 Hours
Version No.: 1.0
Course Prerequisites: Nil
Anti-requisites: —

Course Description:

This course provides a solid foundation in the principles and technologies of the Internet of Things (IoT). It covers IoT architecture, communication protocols, data acquisition, sensor integration, and applications across various domains. It also highlights challenges related to security, scalability, and interoperability in IoT systems.

Course Objectives:

- Understand the architecture and basic building blocks of IoT.
- Explore various communication protocols and standards used in IoT.
- Examine sensor technologies and data acquisition methods.
- Evaluate real-world IoT applications in various sectors.
- Discuss security and privacy issues in IoT networks.

Course Outcomes (COs):

- **CO1 (Understand):** Describe IoT architecture, sensors, and device integration.
- **CO2 (Analyze):** Analyze IoT communication protocols and data processing techniques.
- **CO3 (Apply):** Apply IoT concepts in developing domain-specific applications.
- **CO4 (Analyze):** Evaluate IoT security mechanisms and implementation challenges.

Course Content (Total: 45 Hours)

Module 1: Introduction to IoT and Architecture (CO1 – Understand) – 11 Hours

Topics: Definition, characteristics, history of IoT, layered architecture, IoT enabling technologies, physical and virtual components, sensors and actuators, embedded systems, IoT design considerations.

Module 2: IoT Communication Technologies (CO2 – Analyze) – 11 Hours

Topics: IoT network topologies, M2M, WSN, RFID, Bluetooth, Zigbee, NFC, LoRa, MQTT, CoAP, 6LoWPAN, communication models and APIs, IP addressing in IoT.

Module 3: IoT Data Management and Applications (CO3 – Apply) – 11 Hours

Topics: Data acquisition, storage, and analytics in IoT, real-time data stream processing, cloud and edge computing for IoT, smart applications in healthcare, agriculture, home automation, smart cities.

Module 4: IoT Security and Challenges (CO4 – Analyze) – 12 Hours

Topics: Security requirements in IoT, authentication and access control, cryptographic algorithms, secure communication protocols, privacy challenges, ethical considerations, scalability, interoperability issues.

Textbooks:

- **T1:** Vijay Madisetti and Arshdeep Bahga, *Internet of Things: A Hands-On Approach*, Universities Press, 2015.
- **T2:** Rajkumar Buyya, Amir Vahid Dastjerdi, *Internet of Things: Principles and Paradigms*, Morgan Kaufmann, 2016.

Reference Books:

- R1: Michael Miller, *The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World*, Que Publishing.
- R2: Samuel Greengard, *The Internet of Things*, MIT Press Essentials.

Web Resources:

- [W1] https://iot.eclipse.org/
- [W2] https://www.postscapes.com/internet-of-things-protocols/
- [W3] https://azure.microsoft.com/en-in/overview/iot/

Course Code: AIE 4017	Course Title: Essentials for Machine Learning (ML)	L- T-P-C	3	0	0	3

	Type of Course: Discipline Elective Theory Only					
Version No.		2.0				
Course Pre-requisites		**NIL**				
Anti-requisites		**NIL**				
Course Description		**Machine learning has been emerged as a promising paradigm in the field of Computer science having applications in a wide variety of fields such as communication networks, bioinformatics, image processing, antenna design etc. Now a day's people from multiple discipline are interested in Machine learning due to its applicability in predicting behaviors of highly complex systems, which is otherwise difficult based on traditional optimization techniques in a time bound fashion. The goal of this course is to provide the mathematical prerequisite for starting any Machine learning course to the students coming from various engineering disciplines. This course does not require any prerequisite. The goal of the course is:** 1. **To introduce basic probability and statistics concepts.** 2. **To introduce basic Linear Algebra concepts.** 3. **To enable the students to understand Machine Learning/Deep learning concepts in future.**				
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Essentials for Machine Learning (ML)** and attain **EMPLOYABILITY SKILLS** through **PARTICIPATIVE LEARNING** techniques				
Course Outcomes		**On successful completion of this course the students shall be able to:** **CO1: Understand the basic concepts of Probability and Statistics.** **CO2: Understand the basic concepts of Linear Algebra.** **CO3: Peruse courses on Machine learning/Deep learning in future.**				
Course Content:						
Module 1	Probability	Assignment		Sample space and Events, Interpretation and axioms of Probability, Conditional Probability, Multiplication and total Probability rules, Independence, Bayes' theorem	**08 Sessions**	
Topics: Sample space and Events, Interpretation and axioms of Probability, Conditional Probability, Multiplication and total Probability rules, Independence, Bayes' theorem.						
Module 2	Random variables	Assignment		Probability distribution, Probability mass function, Probability density function, Cumulative distribution function, Mean and	**08 Sessions**	

				variance of a random variable, Binomial, Poisson and Normal random variables, relation between them.	
Topics: Probability distribution, Probability mass function, Probability density function, Cumulative distribution function, Mean and variance of a random variable, Binomial, Poisson and Normal random variables, relation between them.					
Module 3	Introduction to Statistics	Assignment		Pie Chart, Bar chart, Box and whisker plot, Mean, Median, Mode, AM, GM, HM, Quartiles, Deciles, Percentiles, Moments, Skewness, Kurtosis, Measures of Central tendency, Software demonstration.	**08 Sessions**
Topics: Pie Chart, Bar chart, Box and whisker plot, Mean, Median, Mode, AM, GM, HM, Box Plots, time sequences plots, Measures of Central tendency, Software demonstration.					
Module-4	Estimation of Parameters	Assignment		Point estimation, Sampling distribution, Central Limit Theorem, Unbiased estimators, Method of point estimation, Method of moments, method of maximum likelihood, confidence interval estimates of population parameter, student's t distribution, Testing of hypothesis, Chi square distribution, Degrees of freedom	**06 Sessions**
Topics: Point estimation, Sampling distribution, Central Limit Theorem, Unbiased estimators, Residual Analysis and model checking,method of maximum likelihood, confidence interval estimates of population parameter, student's t distribution, Testing of hypothesis, Chi square distribution, Degrees of freedom					
Module-5	Linear Algebra	Assignment		Scalar, Vector, Matrices and Tensors, Norms, Span, Eigen Value, Eigen Vector, The trace operator, Determinant, Proximity measure, Example:	**06 Sessions**

				Principal Component Analysis.	

Topics:

Scalar, Vector, Matrices and Tensors, Norms, Span, Eigen Value, Eigen Vector, The trace operator, Determinant, Example: Principal Component Analysis.

	Project work/Assignment:
	Software demonstration, Probability mass function, Independence, Bayes' theorem, Span, Eigen Value for developing **Employability Skills** through **Participative Learning techniques**. This is attained through assessment component mentioned in course handout.
	REFERENCE MATERIALS: **Text Book(s):** T1. Douglas C. Montgomery and George C. Runger, "Applied Statistics and Probability for Engineers", Sixth Edition, Wiley, 2016 T2. Dimitri P. Bertsekas and John N. Tsitsiklis, "Introduction to probability", MIT press, FALL 2000. T3. Murry R Spiegel and Larry J Stephens, "STATISTICS", Fourth Edition, Schaum's outlines, 2008. T4. Narsingh Deo, "System simulation with digital computer", PHI. T5. G. Strang, "Introduction to Linear Algebra", Fifth Edition, 2016, Wellesley-Cambridge Press, ISBN: 978-09802327-7-6. **Reference Books:** R1. Nils J. Nilsson, "Introduction to Machine Learning" (online Lecture notes on Stanford AI) R2. Shai Shalev-Shwartz, and Shai Ben-David, "Understanding Machine Learning", Cambridge University Press, 2017. **Weblinks** W1.https://presiuniv.knimbus.com/user#/home W2.https://www.javatpoint.com/machine-learning
	Topics relevant to " EMPLOYABILITY SKILLS ": Software demonstration, Probability mass function, Independence, Bayes' theorem, Span, Eigen Value for developing **Employability Skills** through **Participative Learning techniques**. This is attained through assessment component as mentioned in course handout

Course Code: AIE 4018	**Course Title:** **Recommender Systems with Machine Learning and AI** **Type of Course:** **Discipline Elective** **Theory Only**	**L- T-P-C**	3-0-0-3
Version No.	2.0		

Course Pre-requisites		CSE5007
Anti-requisites		NIL
Course Description		This course helps us understand from the early days of collaborative filtering to bleeding-edge applications of deep neural networks and modern machine learning techniques for recommending the best items to every individual user.
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Recommender Systems with Machine Learning and AI** and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING techniques
Course Outcomes		**On successful completion of this course, the students shall be able to:** CO1. Define recommender systems CO2. Use content-based filtering using item attributes CO3.Build model-based methods including matrix factorization, SVD. CO4.Apply deep learning, AI, artificial and recursive neural networks, for session based recommendations. CO5. Analyse recommendation algorithms using various case studies.
Course Content:		

Module 1	Introduction to Recommendation System	Assignment	Seminar		**12 Sessions**
	Topics: Introduction to Recommendation systems, Architecture of Recommendation systems, Basic models of Recommendation systems, Implicit Ratings, Explicit Ratings, Collaborative Filtering, Content-based Recommendation, Advantages and Disadvantages of Content-based recommendations. Knowledge-Based Recommender Systems, Hybrid Recommendation systems, Demographic Recommendation Systems, Applications of Recommendation systems, Advantages and Disadvantages of recommendation systems.				
Module 2	Content-Based Recommender Systems	Assignment	Mini Project		**12 Sessions**
	Topics: Introduction, Architecture of content-based recommendation, Basic components of Content-based systems, Learning User profiles and Filtering- KNN, case-based recommendation, Bayes Classifiers, Rule-based Classifiers, Decision tree classifier.				
Module 3	Model-Based Collaborative Filtering	Assignment	Mini project		**12 Sessions**
	Topics: Introduction to collaborative filtering, Decision and Regression Trees, Rule-based collaborative Filtering-Item-wise vs User-wise models, Item-based collaborative filtering, Naive Bayes Collaborative filtering, Basic matrix Factorization principle, and Singular Value Decomposition.				
Module 4	Hybrid Recommendation Systems	Assignment	Mini project		**12 Sessions**
	Topics: Introduction to Hybrid Recommendation systems, Losses faced by recommendation systems: Bayesian personalized rating (BPR), Weighted approximation rank-pairwise(WARP). Weighted				

Hybrids, Switching Hybrids, Cascade Hybrids, Meta-Level Hybrids, Mixed hybrids, Advantages and disadvantages of Hybrid Recommendation systems.

Module 5	Application and Evaluation of RS	Assignment	Seminar	12 Sessions

Topics:
Case study on YouTube Recommendation, case study on Netflix Recommendation system, Case study on an restaurant ratings given by the customer, Offline Evaluation, Online Evaluation, Goals of Evaluation design- Accuracy, Coverage, Confidence and Trust, Diversity, Robustness and Stability, Scalability, Training and testing of Ratings, RMSE, MAE, Evaluating Ranking via Correlation, Utility, Receiver Operating Characteristics.

Targeted Applications & Tools that can be used:

Targeted Application: Web application development, AI, Operating systems

Tools: Python IDLE, ANACONDA

Application Areas:

- E-Commerce Application
- E-Learning Applications
- E-Business Services
- Artificial Intelligence and Machine Learning
- Enterprise-level/Business Applications

Professionally Used Software: Python, Spyder, Jupyter Notebook, Tensorflow (TFRS), Amazon Personalize.

Project work

- A scenario will be given to the students to be developed as a series of Program/ Application.

On completion of Module 3 and Module 4, students will be asked to develop a Mini Project using Python.

Textbooks

T1.Frank Kane - Building Recommender Systems with Machine Learning and AI, First Edition,2018

T2. Charu C.Aggarwal – Recommender Systems, Springer Publishing Company,2016.

References

R1. Katarzyna Tarnowska,Lynn Daniel – Recommender System for improving customer Loyalty,Springer,1st edition,2020.

R2. EthemAlpaydin, —Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)‖, Third Edition, MIT Press, 2014.

Weblinks

W1.Whttps://presiuniv.knimbus.com/user#/home

W2.https://www.geeksforgeeks.org/recommendation-system-in-python/

Topics relevant to the development of "EMPLOYABILITY SKILLS": Information retrieval of Search Engines Information Retrieval for developing Employability Skills through **Participative Learning** techniques. This is attained through assessment component mentioned in course handout

Course Code: AIE4019
Course Title: Green Computing and Sustainable IT
Type of Course: Program Core
L-T-P-C: 3-0-0-3
Total Hours: 45 Hours
Version No.: 1.0
Course Prerequisites: Nil
Anti-requisites: —

Course Description:
This course provides an overview of sustainable computing practices and green technologies in IT. It introduces students to the environmental impact of computing resources and the principles of designing, operating, and managing sustainable IT infrastructures. Topics include energy efficiency, eco-labeling, green data centers, e-waste management, and policy compliance.

Course Objectives:

- Understand the significance and need for sustainable computing.
- Explore green IT strategies, practices, and technologies.
- Analyze the environmental impact of hardware, software, and infrastructure.
- Learn green data center design, energy metrics, and life cycle assessment.
- Study regulatory and policy frameworks supporting green computing.

Course Outcomes (COs):

- **CO1 (Understand):** Describe the principles and goals of green computing.
- **CO2 (Analyze):** Analyze the energy consumption and environmental impact of IT systems.
- **CO3 (Apply):** Apply sustainable practices in hardware, software, and data center design.
- **CO4 (Analyze):** Evaluate compliance frameworks and sustainability metrics.

Course Content (Total: 45 Hours)
Module 1: Introduction to Green Computing (CO1 – Understand) – 10 Hours
Topics: Definition, importance and goals, historical perspective, environmental concerns, carbon footprint, IT's contribution to environmental problems, green metrics and benchmarking.
Module 2: Sustainable IT Infrastructure (CO2 – Analyze) – 11 Hours
Topics: Green hardware – energy-efficient processors, peripherals, and devices, lifecycle analysis, green software development, power management features, virtualization, cloud computing, and its impact on sustainability.
Module 3: Green Data Centers and Best Practices (CO3 – Apply) – 12 Hours
Topics: Data center efficiency, server consolidation, cooling and power optimization, LEED certification, energy usage metrics (PUE, DCiE), automation, and monitoring tools, green network design.
Module 4: Compliance and Environmental Standards (CO4 – Analyze) – 12 Hours

Topics: ISO 14001, Energy Star, EPEAT, RoHS, WEEE directives, policy initiatives, government regulations, corporate social responsibility, ethical issues, and global green IT initiatives.

Textbooks:

- **T1:** Toby Velte, Anthony Velte, and Robert Elsenpeter, *Green IT: Reduce Your Information System's Environmental Impact While Adding to the Bottom Line*, McGraw-Hill, 2008.
- **T2:** Bud E. Smith, *Green Computing Tools and Techniques for Saving Energy, Money, and Resources*, CRC Press, 2014.

Reference Books:

- R1: Bhuvan Unhelkar, *Green IT Strategies and Applications: Using Environmental Intelligence*, CRC Press.
- R2: San Murugesan and G. R. Gangadharan, *Harnessing Green IT: Principles and Practices*, Wiley.

Web Resources:

- [W1] https://www.energystar.gov/
- [W2] https://www.thegreenitreview.com/
- [W3] https://www.epa.gov/smm/sustainable-management-materials-electronics

Course Code: AIE4020
Course Title: Reinforcement Learning
Type of Course: Program Core (Integrated Theory and Lab)
L-T-P-C: 2-0-2-3
Total Hours: 30 Hours Theory + 30 Hours Lab (15 Weeks)
Version No.: 1.0
Course Prerequisites: Machine Learning or equivalent knowledge
Anti-requisites: —

Course Description:

This course introduces the core concepts, models, and algorithms of Reinforcement Learning (RL), including dynamic programming, Monte Carlo methods, and temporal-difference learning. Students will learn to model real-world problems using RL paradigms and apply algorithms using Python-based libraries. The course includes 15 weeks of lab exercises for hands-on implementation and simulation.

Course Objectives:

- Understand the fundamental principles of reinforcement learning.
- Learn various RL algorithms such as Q-learning, SARSA, and policy gradient methods.
- Explore applications of RL in control, robotics, and games.
- Implement RL models using Python and OpenAI Gym.
- Analyze the performance and convergence of RL algorithms.

Course Outcomes (COs):

- **CO1 (Understand):** Describe the foundational concepts and mathematical formulation of RL problems.
- **CO2 (Analyze):** Analyze the behavior and convergence of key RL algorithms.
- **CO3 (Apply):** Apply dynamic programming and TD learning to solve decision-making tasks.
- **CO4 (Apply):** Implement RL algorithms in practical scenarios using standard environments.

Course Content (Total: 60 Hours)

Module 1: Foundations of Reinforcement Learning (CO1 – Understand) – 8 Theory Hours

Topics: Agent-environment interaction, rewards, policies, value functions, Markov Decision Processes (MDP), Bellman equations.

Module 2: Dynamic Programming and Monte Carlo Methods (CO2 – Analyze) – 8 Theory Hours

Topics: Policy evaluation, policy improvement, value iteration, Monte Carlo prediction and control, exploration vs. exploitation.

Module 3: Temporal Difference Learning (CO3 – Apply) – 7 Theory Hours

Topics: TD prediction, SARSA, Q-learning, n-step bootstrapping, eligibility traces, off-policy learning.

Module 4: Advanced Methods and Applications (CO4 – Apply) – 7 Theory Hours

Topics: Policy gradients, Actor-Critic methods, Deep Q-Networks (DQN), RL in robotics, games, NLP and finance.

Laboratory Experiments (15 Weeks / 30 Hours)

1. Introduction to OpenAI Gym and environment setup.
2. Implement basic MDP environment and simulate agent behavior.
3. Policy evaluation using iterative methods.
4. Value iteration and policy iteration in grid world.
5. Monte Carlo prediction algorithm.
6. Monte Carlo control with ε-soft policies.
7. SARSA implementation on a cliff-walking environment.
8. Q-learning implementation and analysis.
9. N-step TD and eligibility traces.
10. Off-policy learning using Importance Sampling.
11. Policy Gradient with REINFORCE algorithm.
12. Actor-Critic implementation using PyTorch.
13. Deep Q-Network implementation.
14. RL for CartPole using OpenAI Gym.
15. Mini project on game-playing or robotic control task.

Textbooks:

- **T1:** Richard S. Sutton and Andrew G. Barto, *Reinforcement Learning: An Introduction*, 2nd Edition, MIT Press, 2018.
- **T2:** Alessandro Lazaric, *Reinforcement Learning: Theory and Algorithms*, Springer, 2020.

Reference Books:

- R1: Csaba Szepesvári, *Algorithms for Reinforcement Learning*, Morgan & Claypool.
- R2: Marco Wiering, Martijn van Otterlo, *Reinforcement Learning: State-of-the-Art*, Springer.

Web Resources:

- [W1] https://spinningup.openai.com/en/latest/
- [W2] https://gym.openai.com/
- [W3] https://www.deeplearning.ai/
- [W4] https://pytorch.org/tutorials/intermediate/reinforcement_q_learning.html

Course Code: AIE4021
Course Title: AI Ethics and Responsible AI
Type of Course: Program Core (Integrated Theory and Lab)
L-T-P-C: 2-0-2-3
Total Hours: 30 Hours Theory + 30 Hours Lab (15 Weeks)
Version No.: 1.0
Course Prerequisites: Introduction to Artificial Intelligence
Anti-requisites: —

Course Description:

This course explores the ethical, social, and legal challenges posed by Artificial Intelligence. It emphasizes the development and deployment of responsible AI systems, highlighting fairness, transparency, accountability, and alignment with human values. Through theoretical discussions and practical case studies, students will develop critical thinking and implement tools to evaluate ethical AI models.

Course Objectives:

- Understand ethical implications and responsibilities in AI system development.
- Identify bias, discrimination, and privacy issues in data and AI algorithms.
- Study the global frameworks and regulations for responsible AI.
- Apply ethical principles in AI applications through toolkits and frameworks.
- Analyze real-world use cases and propose responsible AI solutions.

Course Outcomes (COs):

- **CO1 (Understand):** Explain key ethical principles and challenges in AI development.
- **CO2 (Analyze):** Analyze social and legal implications of biased or opaque AI systems.
- **CO3 (Apply):** Apply tools and frameworks for evaluating ethical AI.
- **CO4 (Apply):** Implement responsible design and deployment practices in AI systems.

Course Content (Total: 60 Hours)

Module 1: Ethical Foundations in AI (CO1 – Understand) – 8 Theory Hours

Topics: History of AI ethics, human values and ethics in computing, key principles: fairness, accountability, transparency, interpretability, and responsibility.

Module 2: Bias, Discrimination and Data Ethics (CO2 – Analyze) – 8 Theory Hours
Topics: Sources of bias in datasets, algorithmic bias, discrimination, fairness metrics, data privacy, informed consent, GDPR, and ethical data collection.
Module 3: Frameworks, Regulations and Governance (CO3 – Apply) – 7 Theory Hours
Topics: IEEE/EU/UN AI ethics frameworks, explainable AI (XAI), ethical audits, model interpretability tools (LIME, SHAP), AI risk management, compliance mechanisms.
Module 4: Responsible AI in Practice (CO4 – Apply) – 7 Theory Hours
Topics: Ethical AI toolkit walkthrough, responsible design lifecycle, real-world applications (facial recognition, healthcare AI), corporate and governmental case studies.

Laboratory Experiments (15 Weeks / 30 Hours)

1. Analyze an AI dataset for embedded bias.
2. Apply fairness metrics (e.g., statistical parity, equal opportunity).
3. Investigate algorithmic discrimination in classifiers.
4. Evaluate AI models using LIME and SHAP.
5. Conduct an ethical audit using open-source AI audit tools.
6. Study a case involving ethical failures in AI.
7. Redesign an AI pipeline to meet GDPR standards.
8. Use IBM AI Fairness 360 Toolkit for bias detection and mitigation.
9. Conduct model explainability exercise using SHAP.
10. Implement data minimization and privacy-enhancing techniques.
11. Apply ethical scorecard to an existing ML project.
12. Compare transparency levels in different AI systems.
13. Group discussion on regulation frameworks (EU AI Act, OECD guidelines).
14. Develop a responsible AI policy document for a startup.
15. Mini-project: Create an AI solution that meets ethical compliance.

Textbooks:

- **T1:** Virginia Dignum, *Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way*, Springer, 2019.
- **T2:** Markus D. Dubber, Frank Pasquale, Sunit Das, *The Oxford Handbook of AI Ethics*, Oxford University Press, 2022.

Reference Books:

- R1: Cathy O'Neil, *Weapons of Math Destruction*, Crown Publishing Group.
- R2: Shannon Vallor, *Technology and the Virtues: A Philosophical Guide to a Future Worth Wanting*, Oxford University Press.

Web Resources:

- [W1] https://www.ibm.com/blogs/research/2020/09/ai-ethics/
- [W2] https://www.partnershiponai.org/
- [W3] https://aif360.mybluemix.net/
- [W4] https://ai.google/responsibilities/responsible-ai/

Course Code: AIE4023
Course Title: Explainable AI

Type of Course: Program Core (Integrated Theory and Lab)
L-T-P-C: 2-0-2-3
Total Hours: 60 (30 Theory + 30 Lab)

Course Description:
Explainable AI (XAI) focuses on understanding, interpreting, and explaining the decision-making process of AI models. This course explores explainability methods, trust, fairness, interpretability tools, and model transparency. Students will implement techniques using XAI libraries such as LIME, SHAP, and others.

Course Outcomes (COs):

- **CO1 (Understand):** Understand the need for explainability in AI systems.
- **CO2 (Analyze):** Analyze XAI algorithms for interpreting ML models.
- **CO3 (Apply):** Apply LIME, SHAP, and similar tools for local and global model explanations.
- **CO4 (Apply):** Implement explainability in high-stake domains like healthcare and finance.

Modules (30 Hours Theory):

Module 1: Introduction to Explainability (CO1 – Understand) – 8 Hours
Definition of XAI, importance of interpretability, black-box vs white-box models, key principles – transparency, trust, fairness, accountability.

Module 2: XAI Algorithms and Techniques (CO2 – Analyze) – 8 Hours
Local vs global explanations, post-hoc vs ante-hoc explainability, model-specific vs model-agnostic methods, use cases.

Module 3: Tools for Explainability (CO3 – Apply) – 7 Hours
LIME (Local Interpretable Model-agnostic Explanations), SHAP (SHapley Additive exPlanations), PDPs, ICE plots, Anchors.

Module 4: Responsible XAI in Practice (CO4 – Apply) – 7 Hours
Bias in explanation tools, applications in healthcare, finance, justice, case studies, integrating XAI with ML pipelines.

Laboratory Experiments (15 Weeks / 30 Hours):

1. Install and set up LIME and SHAP packages in Python.
2. Use LIME to interpret predictions of a classifier.
3. Visualize feature importance using SHAP.
4. Compare LIME vs SHAP explanations for same data.
5. Generate ICE and PDP plots for a regression model.
6. Case study: Explaining credit scoring decisions.
7. Visualize attention in NLP models (e.g., BERT).
8. Implement model fairness auditing.
9. XAI for healthcare diagnostic systems.
10. Build a transparent rule-based model using decision trees.
11. Apply XAI to image classification (CNN).
12. Develop explanation reports for black-box models.
13. Group discussion on regulatory requirements for explainability.
14. Review of Explainable AI in industry white papers.
15. Mini project: Explainability-driven model deployment.

Textbooks:

- **T1:** Christoph Molnar, *Interpretable Machine Learning*, 2022 Edition.
- **T2:** Patrick Hall et al., *Machine Learning for High-Risk Applications*, O'Reilly Media, 2023.

Reference Books:

- R1: Marco Tulio Ribeiro, *Why Should I Trust You?*, ACM Conference Paper on LIME.
- R2: Finale Doshi-Velez, *Accountability of AI Under the Law*, Berkman Klein Center.

Web Resources:

- [W1] https://christophm.github.io/interpretable-ml-book/
- [W2] https://github.com/slundberg/shap
- [W3] https://github.com/marcotcr/lime
- [W4] https://fairmlbook.org/

Course Code: AIE4024
Course Title: Digital Twins
Type of Course: Program Core (Integrated Theory and Lab)
L-T-P-C: 2-0-2-3
Total Hours: 60 (30 Theory + 30 Lab)

Course Description:
Digital Twin refers to the digital replication of real-world systems. This course introduces digital twin architecture, data modeling, synchronization, real-time analytics, and applications across smart cities, healthcare, and manufacturing.

Course Outcomes (COs):

- **CO1 (Understand):** Understand the architecture and principles of digital twins.
- **CO2 (Analyze):** Analyze synchronization, modeling and data communication.
- **CO3 (Apply):** Apply simulation platforms to build digital twins.
- **CO4 (Apply):** Apply digital twins to solve problems in industrial and smart systems.

Modules (30 Hours Theory):
Module 1: Digital Twin Architecture (CO1 – Understand) – 8 Hours
Definition, history, key components – physical entity, virtual model, data connection. Differences between simulations and twins.
Module 2: Data Acquisition & Synchronization (CO2 – Analyze) – 8 Hours
Sensors, IoT integration, cloud services, data pipelines, real-time communication using MQTT, OPC-UA, edge processing.
Module 3: Tools & Modeling Platforms (CO3 – Apply) – 7 Hours
MATLAB/Simulink, AnyLogic, Unity3D, TwinCAT, IoT platforms (AWS, Azure IoT). Case studies of implementation.
Module 4: Applications & Industry Use Cases (CO4 – Apply) – 7 Hours

Smart manufacturing, predictive maintenance, smart cities, energy grid optimization, healthcare diagnostics.

Lab Experiments (15 Weeks / 30 Hours):

1. Setup a basic twin simulation using Simulink.
2. Connect IoT sensor stream to virtual dashboard.
3. Build a 3D twin model using Unity.
4. Real-time data feed and update loop demonstration.
5. Twin for HVAC system control.
6. Twin modeling in healthcare monitoring.
7. Predictive maintenance simulation.
8. Visualization of twin diagnostics.
9. Real-time dashboard using PowerBI/Node-RED.
10. Cloud-hosted digital twin example.
11. Twin system with rule-based triggers.
12. Twin for robotics with feedback.
13. Smart energy grid simulation.
14. Comparison between simulation and twin.
15. Mini-project in a domain of choice.

Textbooks:

- **T1:** Rajkumar Buyya, *Digital Twin Technologies and Applications*, Springer, 2023.
- **T2:** Jeroen van Meggelen, *Digital Twin: From IoT to AI*, Wiley, 2021.

Web Resources:

- [W1] https://azure.microsoft.com/en-us/solutions/digital-twins/
- [W2] https://developer.ibm.com/tutorials/iot-digital-twin/
- [W3] https://www.twinify.ai/

Course Code: AIE4025
Course Title: Quantum Computing
Type of Course: Program Core (Integrated Theory and Lab)
L-T-P-C: 2-0-2-3
Total Hours: 60 (30 Theory + 30 Lab)

Course Description:
This course provides an introduction to quantum computing including quantum logic, qubits, quantum circuits, gates, and algorithms. Students learn programming via simulators and real quantum computers using IBM Qiskit or similar tools.

Course Outcomes (COs):

- **CO1 (Understand):** Explain quantum principles and concepts like superposition and entanglement.
- **CO2 (Analyze):** Analyze and construct quantum circuits using basic gates.
- **CO3 (Apply):** Implement algorithms like Grover's and Deutsch-Jozsa.
- **CO4 (Apply):** Use IBM Qiskit or equivalent platforms for quantum experimentation.

Modules (30 Hours Theory):

Module 1: Basics of Quantum Computing (CO1 – Understand) – 8 Hours

Qubits, superposition, entanglement, quantum states, measurement, Bloch sphere.

Module 2: Quantum Logic & Circuits (CO2 – Analyze) – 8 Hours

Quantum gates – Pauli, Hadamard, CNOT, Toffoli, circuits, reversible logic.

Module 3: Quantum Algorithms (CO3 – Apply) – 7 Hours

Deutsch-Jozsa, Grover's Search, Quantum Fourier Transform (QFT), overview of Shor's Algorithm.

Module 4: Quantum Platforms & Applications (CO4 – Apply) – 7 Hours

IBM Qiskit, circuit simulation, quantum teleportation, applications in cryptography, optimization.

Lab Experiments (15 Weeks / 30 Hours):

1. Create and visualize single-qubit gates.
2. Implement Bell state.
3. Deutsch-Jozsa algorithm simulation.
4. Grover's search implementation.
5. Construct a reversible circuit.
6. Basic teleportation simulation.
7. Execute circuit on IBM quantum computer.
8. Study quantum measurement and noise.
9. Superdense coding protocol.
10. Compare classical vs quantum speed-up.
11. Use Qiskit Aqua for chemistry simulation.
12. Quantum circuit optimization.
13. Run hybrid quantum-classical workflow.
14. Explore QML (Quantum ML) basics.
15. Mini project using IBM Qiskit.

Textbooks:

- **T1:** Michael A. Nielsen and Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press, 10th Anniversary Edition.
- **T2:** Robert S. Sutor, *Dancing with Qubits: How quantum computing works and how it can change the world*, Packt, 2020.

Web Resources:

- [W1] https://qiskit.org/
- [W2] https://quantum-computing.ibm.com/
- [W3] https://www.microsoft.com/en-us/quantum
- [W4] https://quantumai.google/

Course Code: DSC4011	Course Title: Data Science with Cloud Computing Type of Course: Discipline Elective Theory Only	L- T-P-C	3	0	0	3

Version No.		2.0
Course Pre-requisites		--
Anti-requisites		**NIL**
Course Description		This course introduces a new Transformative, more collaborative way of doing Data Science. It helps in understanding End to End Data pipelines, Ingesting Data in a serverless way and working our way through Data Exploration, Dashboards, and Streaming Data all the way to training and making an operational Machine Learning Model.
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Data Science with Cloud Computing** and attain **EMPLOYABILITY SKILLS** through **PARTICIPATIVE LEARNING** techniques
Course Outcomes		On successful completion of the course the students shall be able to: CO1.Define Data Science and its fundamentals and the process in Data Science. CO2.Explain the process of Ingesting Data into the Cloud Platform. CO3.Analyze real-world problems with Accuracy. CO4.Demonstrate the overall organization of Data and Storage.
Course Content:		

Module 1	**Making Better Decisions Based on Data**	**Assignment**	**Case Study**		**10 Sessions**
	Topics: Many Similar Decisions, Role of Data Engineers, The Cloud Makes Data Engineers Possible, The NaN value, Series CRUD, Series Indexing, The Cloud Turbocharges Data science, Airline on Time Performance Data, Scheduling Monthly Downloads.				
Module 2	**Creating Compelling Dashboards**	**Assignment**	**Case Study**		**10 Sessions**
	Topics: Explain your Model with Dashboards, Loading Data into google Cloud SQL, Creating Google cloud Instance, Interacting with Google cloud Platform, Maximum Likelihood Estimation (MLE)				
Module 3	**Streaming Data: Publication and Ingest**	**Assignment**	**Case Study**		**10 Sessions**
	Topics: Designing the Event Feed, Time Correction, Apache Beam/Cloud Dataflow, Publishing an Event Stream to Cloud Pub/Sub, Real Time Stream processing, Interactive Data Exploration, Exploratory Data Analysis, Loading Flights Data into Big Query, Arrival Delay conditioned on Departure Delay, Evaluating the Model. Time Series Analysis				
Module 4	**Cloud Dataproc**	**Assignment**	**Case Study**		**10 Sessions**

Topics:
Bayes Classifier on Cloud Dataproc, Map Reduce and Hadoop Eco System, Quantization using Spark SQL, Bayes Classification using Pig

Targeted Applications & Tools that can be used:

Targeted Industries like Banking, Transport, e-commerce, healthcare and many more are using data science to make optimal Decisions. The usage of data science helps in rising sales. It can explore historic data, make comparisons and analyses of the market and provide recommendations.
Target Jobs Data Scientist, Data Architect, Data Engineer, Statistician.
Tools:

- Apache Spark
- Jupyter
- Weka

Project work/Assignment:

Mini Project:

Walmart Sales Forecasting in Cloud

- Predict the sales across various departments in each store.
- Predict the effect of markdowns on the sales during the holiday seasons.

Term Assignments:

Consider a Dataset on Bird communities that needs to be analyzed. The data has three columns, a date, a common name, and a count of the number of individuals.

- Count the total number of individuals of each species that were seen in each data file.
- Sort based on the total number of individuals.

Text Book

T1. "Data Science on the Google Cloud Platform: Implementing End-to-End Real-Time Data Pipelines: From Ingest to Machine Learning"-Valiappa Lakshmanan,1st Edition, January 2018.
T2. "Data Analysis in The Cloud"- Domenico Talia ,1st Edition, September 2015

References

R1. Doing Data Science, Straight Talk from the Frontline. O'Reilly. 2014.

Weblinks

W1.https://presiuniv.knimbus.com/user#/home
W2.https://www.geeksforgeeks.org/why-cloud-computing-is-important-in-data-science/

	Topics relevant to " EMPLOYABILITY SKILLS ": Data Extraction, Data wrangling for developing **Employability Skills** through **Participative Learning techniques**. This is attained through assessment component as mentioned in course handout.

Course Code: DSC 4012	**Course Title:** Data Security and Access Control **Type of Course:** Discipline Elective Theory Only			**L- T-P-C**	3	0	0	3
Version No.	2.0							
Course Pre-requisites	--							
Anti-requisites	**NIL**							
Course Description	This course describes fundamental issues and problems in data security and provides technical solutions or facets to the problem of achieving data security. The course also deals with the security of statistical databases, discusses authorization systems, and covers the fundamental ideas of cryptography.							
Course Objective	The objective of the course is to familiarize the learners with the concepts of Data Security and Access Control and attain **EMPLOYABILITY SKILLS** through **Participative Learning** techniques.							
Course Outcomes	On successful completion of the course the students shall be able to: CO1: Describe the basic concepts of a Data Security CO2: Apply appropriate techniques for security Algorithms CO3: Explain the Access Controls mechanisms CO4: Simulate data security algorithms for achieving access control							
Course Content:								
Module 1	Fundamentals of Data Security	Assignment	Algorithms			**8 Sessions**		
	Topics: Introduction to Data Security, Confidentiality, Integrity, Availability, Visibility, Automation, Monitoring, Models and Methodology, and The Security Problem in Computing. The Data Encryption Standard							
Module 2	Data Security Techniques	Assignment/ Case Study	Presentation			**10 Sessions**		
	Topics: Introduction, data masking, data erasure, and backup storage, Anti-malware protection, viruses and other malicious code, Security in Key specified model, Security in Characteristic specified model, File Protection Mechanisms							
Module 3	Authorization Mechanisms in Data Security	Assignment/ Case Study	Coding			**12 Sessions**		

	Topics: Introduction, concept of Un-decidability, Authorization Systems with Tractable Safety Problem, Authorization Systems with Tractable Safety Problem, Grammatical Authorization Systems, Threats in Network, Network Security Controls					
Module 4	An Overview of Data Security Tools, Data Security Policies	Assignment/ Case Study	Simulation of DS tools			**8 Sessions**
	Topics: Introduction to tools available for Data Security, Demonstration of Security features in Linux platform, simulation using more than two computers, demonstration of data leakage during transmission, GDPR (General Data Protection Regulation), Comparative study with India regulation, Data Privacy Act, Role Based Access Control, Organizational Security policies.					
	Targeted Applications & Tools that can be used: Anomaly Deduction, Inclusion Prevention Systems, Firewall, Email Security **Tools:** SAGE Mathematical Library package, VPN					
	Assignment:					
	Term Assignments: 1. Implement Cryptographic algorithms using SAGE 2. Comparative Study on Various Data Security Tools 3. Case Study on GDPR - General Data Protection Regulation 4. Identify Data Leakage in LINUX environment using Authorization Mechanisms					
	Text Book T1. Data Privacy and Security, David Solomon, Springer, T2. Principles of Data Security, Ernst L. Leiss, Plenum Press. New York And London					
	References R1. Intelligence and Security Informatics for International Security, Chen, Hsinchun, Springer Publication 2006 R2. Certified Information Security Professional (CSIP) web portal **Weblinks** W1.https://presiuniv.knimbus.com/user#/home W2. https://www.datasunrise.com/professional-info/what-is-access-control/					
	Topics relevant to "EMPLOYABILITY SKILLS": **":** Email Security, Web Security, GDPR (General Data Protection Regulation), Grammatical Authorization Systems for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout.					

Course Code: DSC 4013	**Course Title:** Soft Computing **Type of Course:** Discipline Elective Theory Only	**L- T-P- C**	3	0	0	3

Version No.		2.0
Course Pre-requisites		--
Anti-requisites		**NIL**
Course Description		Soft computing is an emerging approach in computing that mimics the human mind's remarkable ability to reason and learn in an environment of uncertainty and imprecision. Soft computing is based on biologically inspired methodologies such as genetics, evolution, ant behaviors, particle swarming, human nervous systems, etc. Soft computing is the only solution when we don't have any mathematical modeling of problem-solving (i.e., algorithm), needs a solution to a complex problem in real-time, and easily adapts with changing scenarios and is implemented with parallel computing. It has enormous applications in many application areas such as medical diagnosis, computer vision, handwritten character reconditions, pattern recognition, machine intelligence, weather forecasting, network optimization, VLSI design, etc.
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Soft Computing** and attain **EMPLOYABILITY SKILLS** through **Problem Solving Methodologies**.
Course Outcomes		On successful completion of the course the students shall be able to: CO1: Define the concept and applications of Soft Computing. CO2: Discuss Fuzzy logic concepts and its applications. CO3: Demonstrate Artificial Neural Networks concepts and its applications. CO4: Apply Evolutionary algorithms and hybrid soft computing techniques.
Course Content:		

Module 1	Introduction Soft Computing	Assignment	Analysis		**9 Sessions**

Topics:
Introduction to Soft Computing: Concept of computing systems, "Soft" computing versus "Hard" computing, Characteristics of Soft computing, Applications of Soft computing techniques, Elements of soft Computing.

Module 2	Fuzzy Logic	Assignment	Analysis, Data Collection		**12 Sessions**

Topics:
Fuzzy Logic: Introduction to Fuzzy logic. Fuzzy sets and membership functions. Operations on Fuzzy sets. Fuzzy relations, rules, propositions, implications and inferences. Defuzzification techniques. Fuzzy logic controller design, Predicate logic, Fuzzy decision making.

Module 3	Neural Networks	Case Study	Analysis, Data Collection		**10 Sessions**

Topics:
Neural Network: Neural Networks, Supervised and Unsupervised Learning. Single Layer Perceptron, Multilayer Perceptron, Backpropagation Learning, Network rules and various learning activation functions, Introduction to Associative memory, Adaptive resonance theory and self-organizing map, Recent Applications.
Neural Networks as Associative Memories: Hopfield Networks, Bidirectional Associative Memory. Topologically Organized Neural Networks: Competitive Learning, Kohonen Maps.

Module 4	Evolutionary Computing	Assignment	Analysis, Data Collection		**10 Sessions**

Topics:
Evolutionary Computing: "History of Genetic Algorithm and Optimization working principle, The Schema Theorem, GA operators: Encoding, Crossover, Selection, Mutation, bit wise operation in GA etc. Introduction to ant colony optimization and particle swarm optimization. Integration of genetic algorithm with neural network and fuzzy logic.

Targeted Application & Tools that can be used:

In recent times, engineers have very well accepted soft computing tools such as Fuzzy Computing, ANN, Neuro-Computing and Evolutionary Computing, etc., for carrying out various numerical simulation studies. In the last two decades, these tools independently and in hybrid forms have been successfully applied to varieties of problems. The main objective is to introduce students to the latest soft computing tools. The training of these tools will be helpful to develop rigorous applications in the engineering domain.

Tools:

- MATLAB
- PYTHON
- C

Project work/Assignment:

Mini Project:

- Training of known/classified datasets representing some objects/pattern using various ANN learning methods including Perceptron, BPN, Adaline, Associative memory networks, Hopfield, kohenen networks.
- Classification of new input feature set/pattern based on training & learning
- Applying GA search to optimize the solutions. Implementation of the GA procedure.

Text Book

T1. Principles of Soft computing, Shivanandam, Deepa S. N Wiley India, 3rd Edition 2019
T2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Third Edition, Wiley.

References

R1. Kumar S., "Neural Networks - A Classroom Approach", Tata McGraw Hill, 2nd Edition 2017.
R2. Eiben A. E. and Smith J. E., "Introduction to Evolutionary Computing", Second Edition, Springer, Natural Computing Series, 2nd Edition, 2015.

R3. Fakhreddine O. Karray, and Clarence W. De Silva. Soft computing and intelligent systems design: theory, tools, and applications. Pearson Education, 2009.

Weblinks
W1.https://presiuniv.knimbus.com/user#/home
W2.https://www.geeksforgeeks.org/fuzzy-logic-introduction/

Topics relevant to " EMPLOYABILITY SKILLS ": Solving real world problems with uncertainty using Nature Inspired Algorithms for developing **Employability Skills** through **Problem Solving Methodologies** . This is attained through assessment component mentioned in course handout

Course Code: DSC4014	**Course Title: Time Series Analysis and Forecasting** **Type of Course: Discipline Elective Theory Only**	**L- T-P-C**	3	0	0	3

Version No.	2.0	
Course Pre-requisites	CSE5007	
Anti-requisites	**NIL**	
Course Description	The course will provide a basic introduction to time series analysis. This theory based course covers topics in time series analysis and some statistical techniques on forecasting. Time series regression, exploratory data analysis, AR models, Seasonal Models, GARCH Models and Box-Jenkins approach are the major topics covering in this course. R and RStudio will be required for this class.	
Course Objective	The objective of the course is to familiarize the learners with the concepts of **Time Series Analysis and Forecasting** and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING techniques	
Course Outcomes	On successful completion of the course the students shall be able to CO1.Select appropriate model, to fit parameter values and make concise decisions based on forecasts obtained CO2.Demonstrate an understanding of the principles behind modern forecasting techniques. CO3.Apply concepts to real time series data using packages.	
Course Content:		

Module 1	Introduction	Assignment	Data Analysis task		**9 Sessions**

Topics:
Background for time series analysis, Examples of Time Series, Objectives of Time Series Analysis, Characteristics of Time Series, Time Series Techniques, Approaches used for time series forecasting, ETS (Error, Trend, Seasonality) models to make forecasts, Decomposition method, Case study on decomposition method, Model forecast theory, Model forecast hands-on, stochastic process.

Module 2	Time Series Regression and Exploratory Data Analysis	Assignment	Data analysis		**10 Sessions**

Topics:

	Time series pipeline, Classical Regression in the Time Series Context, Exploratory Data Analysis, Stationary Models and the Autocorrelation Function, Detrending and De-seasonalizing Smoothing, Introduction to Time Series Analysis with R,					
Module 3	AR models	Assignment	Data analysis			**10 Sessions**
	Topics: Models for Stationary Time Series, Models for Non-Stationary Time Series, Identification, Forecasting, ARIMA (Autoregressive, Integrated, Moving Average) models, AR model, and MA model.					
Module 4	Additional models, Spectral Analysis and packages	Case Study	Data analysis			**10 Sessions**
	Topics: Seasonal Models, Time Series Regression Models, GARCH Models, Seabird Model. Preparing model using ITSM, Time series using astsa, ARIMA models is to use sarima from astsa Preparing model using LSTM for weather forecasting using ARIMA.					
	Targeted Application & Tools that can be used: **Targeted Applications**: Time series analysis on economics, finance, natural sciences, health care and more **Tools:** • R package astsa (Applied Statistical Time Series Analysis) • The package ITSM2000 (https://extras.springer.com/)					
	Project work:					
	Mini Project: **Choose any suitable real time dataset and build time series forecast models.** **Example:** In the Air Passengers dataset set, go back 12 months in time and build the ARIMA forecast for the next 12 month. Investigate following questions Is the series stationary? If not what sort of differencing is required? What is the order of your best model? What is the AIC of your model? What is the order of the best model predicted by auto_arima() method?					
	Text Book T1.Montgomery DC, Jennings CL, Kulahci M. Introduction to time series analysis and forecasting. John Wiley & Sons; 2015 Apr 21. T2.Brockwell & Davis (2016) Introduction to Time Series and Forecasting, 3rd edition, Springer. T3.Shumway & Stoffer (2011) Time Series Analysis and its applications, with examples in R , 3rd edition, Springer.					
	References R1.Box GE, Jenkins GM, Reinsel GC, Ljung GM (2015) Time series analysis: forecasting and control. John Wiley & Sons R2.Cryer & Chan (2008) Time Series Analysis with Applications in R, Springer R3.Prado & West (2010) Time Series: Modeling, Computation, and Inference Chapman & Hall **Weblinks** W1.https://www.coursera.org/courses?query=time%20series%20analysis W2. https://www.tableau.com/learn/articles/time-series-forecasting W3.https://presiuniv.knimbus.com/user#/home					

	Topics relevant to development of "EMPLOYABILITY SKILLS": Information retrieval of Search Engines Information Retrieval for developing Employability Skills through PROBLEM SOLVING techniques. This is attained through assessment component mentioned in course handout

Course Code: DSC 4015	**Course Title: IOT Data Analytics** **Type of Course: Discipline Elective Theory Only**	**L- T-P- C**	3	0	0	3

Version No.		2.0
Course Pre-requisites		--
Anti-requisites		**NIL**
Course Description		This course helps in understanding the context of analytics in IoT data. Strategies to collect IoT data in order to enable analytics. Skills learnt will enable to understand the tradeoffs in streaming and batch processing. Data science techniques such as machine learning, deep learning, and forecasting are applied on IoT data. This course also teaches how to implement machine learning methods and ARIMA forecasting on IoT data. Deep learning will be described along with a way to get started experimenting with it on AWS.
Course Objective		The objective of the course is to familiarize the learners with the concepts of IoT Data Analytics and attain **EMPLOYABILITY SKILLS** through **Problem Solving** Methodologies.
Course Outcomes		On successful completion of the course the students shall be able to: CO1: Discuss the challenges of IoT Analytics. CO2: Apply strategies and techniques to collect IoT data. CO3: Apply data science techniques on IoT data
Course Content:		

Module 1	IoT analytics, challenges, devices and networking protocols	Assignment	Data Analysis task		**12 Sessions**

Topics:
Defining IoT Analytics and Challenges Defining IoT Analytics. IoT analytics challenges, Core IoT Functional Stack, Functional blocks of an IoT ecosystem
IoT Devices and Networking Protocols IoT devices Networking basics IoT networking connectivity protocols
IoT networking data messaging protocols Message Queue Telemetry Transport (MQTT) Hyper-Text Transport Protocol (HTTP) Data Distribution Service (DDS)

Module 2	Data – Strategies, Techniques and Exploring IoT Data	Assignment	Analysis, Data Collection		**12 Sessions**

	Topics: Collecting All That Data - Strategies and Techniques Designing data processing for analytics Applying big data technology to storage Apache Spark for data processing Exploring IoT Data Exploring. Data analytics tools				
Module 3	Data Science for IoT Analytics	Case Study	Data analysis task		**13 Sessions**
	Topics: Feature engineering with IoT data Validation methods Understanding the bias–variance trade off Comparing different models to find the best fit Random Forest models Gradient Boosting Machines Anomaly detection, Forecasting, scaling issues.				
	Targeted Application & Tools that can be used: Employment opportunities are available in Companies like Hexaware, Episteme, Randstad. Siemens, Accenture etc. as IoT Data Engineer Tools R Python Microsoft Azure Stream Analytics. AWS IoT Analytics. SAP Analytics Cloud. Oracle Stream Analytics and Oracle Edge Analytics.				
	Project work				
	Mini Project: Develop a IoT application for real time data analysis of manufacturing sector. The automated IoT Analytics should aid in using real time data to watch out for certain patterns and send alerts to the concerned departments. It should enable smart manufacturing.				
	Text Book T1.“Analytics for the Internet of things (IoT)”, Andrew Minteer, Packt, 2017				
	References R1.WInternet of Things and Big Data Analytics for Smart Generation, Valentina E Balas, Springer **Weblinks** W1.https://presiuniv.knimbus.com/user#/home W2.https://www.orientsoftware.com/blog/iot-data-analytics/				
	Topics relevant to “EMPLOYABILITY SKILLS”: Processing geospatial IoT Data, protocols Message Queue Telemetry Transport (MQTT) Hyper-Text Transport Protocol (HTTP) Constrained Application Protocol (CoAP) Data Distribution Service (DDS), Random Forest models Gradient Boosting Machines Anomaly detection for developing Employability Skills through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.				

Course Code: DSC 4016	**Course Title: Probabilistic graph Models** **Type of Course: Discipline Elective** **Theory Only**	**L- T-P- C**	3	0	0	3

Version No.		2.0
Course Pre-requisites		--
Anti-requisites		**NIL**
Course Description		Probabilistic graphical models are used to model stochasticity (uncertainty) in the world and are extremely popular in AI and machine learning. The course will cover two classes of graphical models: Bayesian belief networks (also called directed graphical models) and Markov Random Fields (undirected models). After introducing the two frameworks the course will focus on recent advances in inferences and learning with graphical models, including topics such as loopy belief propagation, variational approximations, conditional Markov random fields and others.
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Probabilistic graph Models** and attain EMPLOYABILITY SKILLS through PARTICIPATIVE LEARNING techniques
Course Outcomes		On successful completion of the course the students shall be able to: CO1: Apply key concepts of Statistics to solve problems. CO2: Analyze the properties of distributions encoded by graphs CO3: Illustrate Inference in graphic models CO4: Illustrate Learning in graphic models
Course Content:		

Module 1	Fundamentals of Probability and Graph Theory	Assignment	Understanding all standard probability distributions		**9 Sessions**

Topics:
Fundamentals of Statistics and Probability, Conditional Probability, Conditional Independence, Joint Distributions, Baye's Theorem, Gaussians rule, Probability Distributions, Fundamentals of Graph Theory - Paths, Cliques, Sub-graphs, Cycles and Loops.

Module 2	Graphical Models	Assignment	Construction of Markov chain model for real time problems		**9 Sessions**

Topics:
Directed Models: Bayesian Network; Undirected Models: Markov Random Fields; Parameterization of MRFs, Independencies, Duality and optimality, Non parametric Bayes hierarchical models.

Module 3	Inference in Graphical Models	Assignment	Study about some problems based on Monte Carlo method		**9 Sessions**

Topics:

	Inference in Graph Models, Variable Elimination; Belief Propagation, Sampling Methods: Markov Chain Monte Carlo, Convexity and optimization, Hidden Markov Model, Viterbi Algorithm.					
Module 4	Learning in Graphical Models	Assignment	Applications of Naïve Bayes Classifier			**10 Sessions**
	Topics: Learning in Graph Models, Maximum Likelihood Estimation, Naïve Bayes Classifier, Conditional Random Fields, constrained optimization problem					
	Targeted Application & Tools that can be used: Targeted employment sector is to acquire knowledge to analyze the given problem to frame Probabilistic graphical models which are a powerful framework for representing complex domains using probability distributions, with numerous applications in machine learning, computer vision, natural language processing and computational biology. **Tools:** • Python • HUGIN Tool for Learning Bayesian Networks • MATLAB Toolbox for Bayesian net					
	Assignment:					
	Term Assignments: • **Analysis and Application of Bayesian Network to real time problems** Understanding the given problem, analyze accordingly to apply Bayesian network and convert the problem in a Bayesian Network. The answering the required queries. • **A short survey of the Monte Carlo Method** Study and analyze few realistic problems to apply Monte Carlo Technique to answer the solution of the problem. • **A short survey of the Markov Chain & Hidden Markov Method** Study and analyze few realistic problems to convert into Markov chain & Hidden Markov to answer the required problem.					
	Text books(s) T1. S. Lauritzen. Graphical Models. Oxford University Press, 1996. T2. David J.C. Mackay. Information theory, inference, and learning algorithms. Cambridge, UK: Cambridge University Press 2003. **References(s)**					

	R1.https://towardsdatascience.com/introduction-to-probabilistic-graphical-models-b8e0bf459812. **Weblinks** W1.https://presiuniv.knimbus.com/user#/home W2.https://home.cs.colorado.edu/~mozer/Teaching/syllabi/ProbabilisticModels//
	Topics relevant to development of "EMPLOYABILITY SKILLS": Conditional Independence , Markov Random Fields; Parameterization of MRFs, Independencies,, Metropolis Hastings Algorithm, Hidden Markov Model, Viterbi Algorithm for developing Employability Skills through Participative Learning techniques. This is attained through assessment component mentioned in course handout

Course Code: DSC4017	**Course Title:** Social Network Analysis **Type of Course:** Discipline Elective Theory Only	**L- T-P-C**	3	0	0	3

Version No.		2.0
Course Pre-requisites		--
Anti-requisites		**NIL**
Course Description		The rapid growth of social media has given the mass consumers a powerful tool to create knowledge and propagate opinions. At the same time, social media has created an unprecedented opportunity for companies to engage real-time interactions with consumers. In addition, the size and richness of social media data has provided companies an unusually deep reservoir of consumer insights to transform the business and marketing operations. The social media analytics course will enable students to grasp the analytics tools to leverage social media data. The course will introduce tools such as engagement analytics, sentiment analysis, topic modeling, social network analysis, identification of influencers and evaluation of social media strategy.
Course Objective		The objective of the course is to familiarize the learners with the concepts of **Social Network Analysis** and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING techniques
Course Outcomes		**On successful completion of this course the students shall be able to:** CO1: Interpret the social network landscape and appreciate the importance of analytics in business. CO2: Apply appropriate native analytics and measurement tools to analyze data in different social platforms CO3: Use Natural Language Processing for efficient mining of web data CO4: Demonstrate meaningful insights with actionable and strategic recommendations.
Course Content:		

Module 1	**Network Science**	Quiz/Assignment	Analysis		**9 Sessions**
	Topics: Introduction to semantic web, limitation of current web, Central Measures, Community Analysis, CPM, Homophily and Triadic Closure, Affiliation Networks, Schelling model of Segregation, Current Social Media landscape, working environment, Getting analyzing and visualizing the data, Getting started with the toolset, Need for SMA, Applications of SMA in different areas. Connecting, Capturing and cleaning of Social Data. Social network analysis of social and behavioral sciences APIs in nutshell, Introduction to authenticate techniques, Parsing API outputs, Basic cleaning techniques. Exploring GitHub's API, Analyzing GitHub Interest Graphs, Computing Graph Centrality Measures.				
Module 2	**Analyzing Social graphs and Sentiment**	Quiz	Project Development		**10 Sessions**
	Topics: Modeling and aggregating social network data, Exploring Facebook's Social Graph API, Open Graph Protocol, Analyzing Social Graph Connections, Mining your posts, Facebook Pages. Exploring Twitter's API, Analyzing Twitter using sentiment analysis, Frequency Analysis, Examining Patterns in Retweets.				
Module 3	**Mining web pages**	Assignment	Project Development		**11 Sessions**
	Topics: Scraping, Parsing and Crawling the Web: BFS in Web Crawling, Discovering Semantics by Decoding Syntax: NLP Illustrated Step-by-Step, Sentence Detection in Human Language Data, Document Summarization, Entity-Centric Analysis: A Paradigm Shift, Summarizing Human Language Data, Quality of Analytics for Processing Human Language Data, trust models based on subjective logic Campaigns and Consumer Reaction Analytics on YouTube: Structured and Unstructured, Scope and Process, Getting the data, Data pull, Data processing and Data analysis, Attack spectrum and counter measures.				
Module 4	**Recommender Systems and SEO**	Quiz	Group Discussion		**8 Sessions**
	Topics: Content-Based Recommendation and Collaborative Filtering, introduction to SEO, Keyword research Process, avoid negative SEO, Search Engines, Google PageRank, IBM HITS,				
	Targeted Application & Tools that can be used: The applications of Social Media Analytics have been seen in industrial sector, sports and games, local governments services, tourism and hospitality services, politics, social issues, disaster management, community development issues, commerce and business applications, fashion industry, agricultural activities, online media, medical and health related services as well as supplier chain services. **Tools**: Google Colab or Jupyter Notebook(Anaconda).				
	Project work				
	On completion of all Modules, students will be given a Mini Project to build a deep learning model for a given application. Sample mini projects include:				

	Twitter Summaries Twitter is famous for its character-limited posts. We can use this social media platform for an innovative summary-writing project. Consolidate the takeaways from a topic or reading discussed. Students should be able to understand the text, coherently organize the points and capture the central idea with 280 words, which is the character limit on Twitter. **Hashtag activism** Information and communication technologies provide a tremendous tool for spreading awareness and highlighting issues that may not be adequately represented in the mainstream media. Hashtag activism, in particular is concerned with driving social media traffic to oft-neglected topics. We can devise a project-based activity to teach our students about social justice, human rights, equality etc.
	Text Book(s): **T1.Mathew A. Russell, "*Mining the Social Web*", O'Reilly, 3rd Edition, 2019.**
	Reference(s): **R1.Marco Bonzanini, "*Mastering Social Media Mining with Python*", PacktPub, 2016.** **Weblinks** W1.https://presiuniv.knimbus.com/user#/home W2.https://onlinecourses.nptel.ac.in/noc22_cs117/preview
	Topics relevant to "EMPLOYABILITY SKILLS: **Recommender Systems and SEO** for developing Employability Skills through PROBLEM SOLVING techniques. This is attained through assessment component mentioned in course handout

Course Code: DSC4018	**Course Title: Application of Probability theory in Computer Science** **Type of Course: Theory Course**	**L- T-P- C**	3	0	0	3
Version No.	2.0					
Course Pre-requisites	--					
Anti-requisites	**NIL**					
Course Description	For both engineers and researchers in the field of Computer science, it is common to develop models of real-life situations and develop solutions based on those models. In this course, our objective is to give an idea regarding the application of probability theory in the modeling and analyzing different kinds of computer systems. We particularly focus on time complexity analysis of different algorithms, reliability analysis of networks, physical layer security as well as resource allocation in 5G and beyond. The target audience for this course is Masters and Ph.D., students. The student should have basic Probability concepts as a pre-requisite. With a good knowledge of different techniques of applying Probability theory in modeling/analyzing computer systems, the students will be able to develop efficient solutions for complex and challenging real-life problems.					

Course Objective		The objective of the course is to familiarize the learners with the concepts of **Application of Probability theory in Computer Science** and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING techniques
Course Outcomes		**On successful completion of this course the students shall be able to:** CO1: Develop mathematical models for various computer systems. CO2: Apply an appropriate probability concept to analyze the system. CO3: Apply appropriate Reinforcement learning techniques to solve complex real-life problems. CO4: Apply statistical Inference concepts to estimate parameters which are unknown to the model.
Course Content:		

Module 1	Review on Basic Concepts	Assignment		Basic Probability Concepts	**12 Sessions**
	Topics: Basic probability concepts, Conditional probability, Expectation, random variables, Law of Large Numbers, well-known distributions, order statistics, and a basic idea of hypothesis testing, Central Limit Theorem. Applications in reliability analysis of VLSI chips, performance analysis of telephone network and binary communication channels, and application in the cognitive radio network.				
Module 2	Stochastic processes	Assignment		Markov process	**12 Sessions**
	Topics: Markov chain, Random Walks, Generating Functions, Birth-death process, application in modeling the behavior of wireless channels, memory interference problem, performance analysis of medium access protocols, analyzing the time complexity in the implementation of two stacks using a single array.				
Module 3	Reinforcement learning	Assignment		Understanding different Reinforcement learning techniques	**12 Sessions**
	Topics: Simple Applications of Decision Theory, Model Comparison, Markov decision process, value and policy iteration, off-policy and on-policy learning techniques (e.g., SARSA, Q-learning), Multi-arm Bandit problem (MAB), modeling resource allocation in 5G as MAB, Hidden Markov model (HMM), application of HMM in physical layer security.				
	Targeted Applications & Tools that can be used: Markov's inequality Chernoff bound				
	Project work				
	-Performance analysis of the LRU stack model -Modeling multiprocessor systems and analyzing the reliability -Modeling handovers in wireless networks and performance analysis of handover algorithms. -A short survey on Monte Carlo simulation techniques.				

	REFERENCE MATERIALS: Text Book(s): T1. Kishore S. Trivedi, "Probability and Statistics with Reliability, Queuing, and Computer Science Applications", PHI. T2. Dimitri P. Bertsekas and John N. Tsitsiklis, "Introduction to Probability", MIT Press, FALL 2000. T3. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT press. T4. Narsingh Deo, "System simulation with digital computer", PHI **Reference links:** R1. https://open.umn.edu/opentextbooks/textbooks/21 **Weblinks** W1.https://presiuniv.knimbus.com/user#/home. W2.https://www.cuemath.com/data/probability/.
	Topics relevant to the development of "EMPLOYABILITY SKILLS": Information retrieval of Search Engines Information Retrieval for developing EMPLOYABILITY SKILLS through PROBLEM SOLVING techniques. This is attained through assessment component mentioned in course handout

Course Code: DSC4019
Course Title: Digital Image Processing
L-T-P-C: 2-0-2-3
Type of Course: Program Core
Total Hours: 30 Hours Theory + 15 Weeks Lab
Course Description:
This course introduces fundamental techniques for digital image processing and analysis, including enhancement, transformation, segmentation, and recognition. It focuses on practical implementation using open-source tools such as OpenCV and Python.
Course Objectives:

- To understand the fundamentals of image processing.
- To explore image enhancement, filtering, and segmentation techniques.
- To learn image compression and object recognition methods.
- To apply open-source libraries for real-time image processing applications.

Course Outcomes:

- **CO1 (Analyze):** Analyze image representations and enhancement techniques.
- **CO2 (Analyze):** Analyze image segmentation and transformation techniques.
- **CO3 (Apply):** Apply filtering and compression algorithms.
- **CO4 (Apply):** Apply image classification using machine learning models.

Modules:
Module 1 – Image Fundamentals and Enhancement (CO1) – 8 Hours
Digital image fundamentals – pixel operations, image representation, histogram equalization, contrast enhancement, intensity transformation, color spaces.
Module 2 – Image Filtering and Transformation (CO2) – 7 Hours
Spatial domain filtering – smoothing and sharpening, frequency domain filtering – Fourier transform, convolution, edge detection – Sobel, Canny, Laplacian.
Module 3 – Segmentation and Compression (CO3) – 7 Hours
Segmentation – thresholding, clustering-based methods, region growing, edge-based

segmentation. Compression – lossless and lossy methods, run-length, Huffman coding, JPEG.

Module 4 – Object Detection and Machine Learning Applications (CO4) – 8 Hours
Feature extraction – corners, blobs, SIFT, HOG, classification using k-NN, SVM, basics of CNNs for image recognition.

Lab Experiments (15 Weeks)

1. Perform basic operations on images using OpenCV (read, write, resize, crop).
2. Histogram equalization and contrast adjustment.
3. Implement smoothing and sharpening filters.
4. Frequency domain filtering and edge detection.
5. Implement segmentation using thresholding and region growing.
6. Color space conversion and masking.
7. Morphological operations: erosion, dilation.
8. Image compression using RLE and Huffman coding.
9. Apply SIFT and HOG for feature extraction.
10. Object classification using k-NN.
11. Object classification using SVM.
12. Introduction to CNN for image classification.
13. Mini-project planning – dataset selection.
14. Implementation of mini-project (phase 1).
15. Final implementation and demo.

Textbooks:

- Rafael C. Gonzalez and Richard E. Woods, *Digital Image Processing*, 4th Edition, Pearson, 2018.

Reference Books:

- Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer, 2022.

Web Resources:

- https://opencv.org
- https://scikit-learn.org
- https://towardsdatascience.com
- https://www.kaggle.com
- https://archive.ics.uci.edu/ml/index.php

Course Code: DSC4020
Course Title: Data Mining and Pattern Recognition
L-T-P-C: 2-0-2-3
Type of Course: Program Core
Total Hours: 30 Hours Theory + 15 Weeks Lab
Course Description:
This course focuses on techniques and models used in data mining and pattern recognition. It emphasizes classification, clustering, association rule mining, and pattern discovery with practical applications using Python and data science libraries.
Course Objectives:

- To understand core concepts of data mining and pattern recognition.
- To analyze data using clustering, classification, and pattern analysis techniques.
- To apply data mining algorithms for real-world datasets.

- To implement models for association rules and pattern extraction.

Course Outcomes:

- **CO1 (Analyze):** Analyze the data preprocessing and preparation techniques.
- **CO2 (Analyze):** Analyze classification and clustering algorithms.
- **CO3 (Apply):** Apply association rule mining and dimensionality reduction.
- **CO4 (Apply):** Apply pattern recognition techniques using supervised and unsupervised learning.

Modules:

Module 1 – Introduction and Data Preprocessing (CO1) – 8 Hours
Data mining tasks, KDD process, data types, cleaning, integration, normalization, transformation, reduction.

Module 2 – Classification and Clustering (CO2) – 7 Hours
Classification: Decision Trees, k-NN, Naïve Bayes, model evaluation. Clustering: K-means, hierarchical clustering, DBSCAN.

Module 3 – Association Rules and Feature Selection (CO3) – 7 Hours
Apriori and FP-Growth algorithms, support, confidence, lift. Dimensionality reduction – PCA, LDA.

Module 4 – Pattern Recognition and Applications (CO4) – 8 Hours
Supervised vs unsupervised learning, SVM, ROC curves, case studies – fraud detection, recommendation systems.

Lab Experiments (15 Weeks)

1. Data preprocessing – cleaning, transformation.
2. Classification using Decision Trees.
3. Classification using k-NN.
4. Naïve Bayes classifier.
5. K-means clustering.
6. Hierarchical and DBSCAN clustering.
7. Association rule mining using Apriori.
8. FP-Growth algorithm.
9. Dimensionality reduction using PCA.
10. LDA-based feature selection.
11. Pattern classification using SVM.
12. Evaluate models using accuracy, precision, recall, F1-score.
13. ROC curve analysis.
14. Case study implementation – fraud detection.
15. Final mini-project on pattern classification.

Textbooks:

- Jiawei Han, Micheline Kamber, and Jian Pei, *Data Mining: Concepts and Techniques*, 4th Edition, Morgan Kaufmann, 2022.

Reference Books:

- Tan, Steinbach, and Kumar, *Introduction to Data Mining*, Pearson, 2018.

Web Resources:

- https://scikit-learn.org
- https://www.kaggle.com
- https://towardsdatascience.com
- https://archive.ics.uci.edu/ml/index.php

Course Code: DSC4021
Course Title: Graph Analytics and Network Science
L-T-P-C: 2-0-2-3
Type of Course: Program Core
Total Hours: 30 Hours Theory + 15 Weeks Lab
Course Description:
This course explores the principles of graph theory and network science as applied to real-world problems in data science, social networks, biology, and web analytics. Students learn to model, analyze, and interpret network structures using computational tools.
Course Objectives:

- To understand graph models and their applications in data analytics.
- To analyze large-scale networks using centrality, connectivity, and clustering.
- To apply graph algorithms for community detection and shortest paths.
- To implement network analytics using Python libraries.

Course Outcomes:

- **CO1 (Analyze):** Analyze graph structures and properties.
- **CO2 (Analyze):** Analyze metrics like centrality, clustering, and paths.
- **CO3 (Apply):** Apply graph algorithms in real-world networks.
- **CO4 (Apply):** Apply network analysis using tools like NetworkX.

Modules:
Module 1 – Graph Fundamentals and Representations (CO1) – 8 Hours
Graphs and their types, adjacency matrix and list, graph traversal (DFS, BFS), network data modeling.
Module 2 – Network Metrics and Structures (CO2) – 7 Hours
Degree, betweenness, closeness, eigenvector centrality, clustering coefficients, path lengths.
Module 3 – Graph Algorithms and Applications (CO3) – 7 Hours
Shortest paths (Dijkstra, Bellman-Ford), connected components, community detection (modularity, Louvain method), page rank.
Module 4 – Tools and Case Studies in Network Science (CO4) – 8 Hours
NetworkX, Gephi, Cytoscape for visual analysis. Applications in epidemiology, recommendation systems, web graphs, citation networks.
Lab Experiments (15 Weeks)

1. Create and visualize graphs using NetworkX.
2. Implement BFS and DFS.
3. Compute degree and other centrality measures.
4. Apply clustering coefficient and shortest path algorithms.
5. Analyze real-world datasets – social media graphs.
6. Apply PageRank algorithm.
7. Community detection using Louvain method.
8. Explore visualization using Gephi.
9. Citation network analysis.
10. Web graph and hyperlink structure.
11. Recommendation systems using link prediction.
12. Case study: Epidemic modeling using graphs.
13. Mini-project planning – dataset exploration.
14. Implementation phase 1.
15. Final implementation and report submission.

Textbooks:

- Alan Said and Alejandro Bellogín, *Graph-based Methods in Data Mining and Knowledge Discovery*, Springer, 2022.

Reference Books:

- Newman, M.E.J., *Networks: An Introduction*, Oxford University Press, 2018.

Web Resources:

- https://networkx.org
- https://gephi.org
- https://cytoscape.org
- https://towardsdatascience.com
- https://www.kaggle.com

Course Code: DSC4022
Course Title: Geospatial Data Science
L-T-P-C: 2-0-2-3
Type of Course: Program Core
Total Hours: 30 Hours Theory + 15 Weeks Lab
Course Description:
This course provides students with foundational and advanced knowledge of geospatial data science. Topics include geospatial data acquisition, storage, analysis, and visualization. It emphasizes the use of GIS software and Python for solving spatial problems.
Course Objectives:

- To understand concepts of spatial data and GIS.
- To perform spatial analysis using Python and GIS tools.
- To explore satellite imagery and remote sensing data.
- To implement geospatial visualization and data-driven decision-making.

Course Outcomes:

- **CO1 (Analyze):** Analyze geospatial data types, formats, and storage methods.
- **CO2 (Analyze):** Analyze spatial relationships and visualization techniques.
- **CO3 (Apply):** Apply spatial analytics using Python and open GIS tools.
- **CO4 (Apply):** Apply geospatial analysis to real-world case studies.

Modules:
Module 1 – Introduction to Geospatial Data (CO1) – 8 Hours
Types of spatial data – raster and vector, coordinate reference systems, GPS and GIS fundamentals, geospatial file formats (GeoJSON, Shapefile), data sources (OpenStreetMap, Landsat).
Module 2 – Spatial Analysis Techniques (CO2) – 7 Hours
Map overlays, buffers, proximity analysis, spatial joins, point pattern analysis, geocoding, spatial interpolation.
Module 3 – Geospatial Tools and Visualization (CO3) – 7 Hours
Use of Python libraries (GeoPandas, Shapely, Folium), QGIS overview, heat maps, choropleth maps, 3D maps, satellite data visualization.
Module 4 – Applications and Case Studies (CO4) – 8 Hours
Disaster management, urban planning, environmental monitoring, location-based services, agriculture and health applications using geospatial insights.
Lab Experiments (15 Weeks)

1. Introduction to GIS tools and dataset loading.

2. Coordinate system conversion.
3. Vector data manipulation using QGIS.
4. Raster data processing.
5. Spatial joins and querying.
6. Buffer and overlay analysis.
7. Visualizing maps using Folium.
8. Generating heatmaps with Python.
9. Working with satellite data.
10. Land use classification.
11. Distance and network analysis.
12. Case study: Urban development.
13. Mini project planning – scenario selection.
14. Implementation of mini project – phase 1.
15. Final project submission and demo.

Textbooks:

- Bonny P. McClain, *Applying Geospatial Analytics in Business and Everyday Life*, O'Reilly, 2022.

Reference Books:

- Kang-Tsung Chang, *Introduction to Geographic Information Systems*, 9th Edition, McGraw-Hill, 2021.

Web Resources:

- https://www.qgis.org
- https://geopandas.org
- https://earthdata.nasa.gov
- https://gdal.org
- https://towardsdatascience.com

Course Code: DSC4023
Course Title: Marketing and Consumer Analytics
L-T-P-C: 3-0-0-3
Type of Course: Program Core
Total Hours: 45 Hours Theory
Course Description:
This course focuses on analytical tools and techniques to understand, predict, and influence consumer behavior. It combines marketing theory with data analytics to drive decision-making and optimize strategies.
Course Objectives:

- To introduce students to the fundamentals of marketing analytics.
- To enable the application of statistical and machine learning models to consumer data.
- To analyze consumer trends, segments, and preferences.
- To explore marketing campaign effectiveness and ROI.

Course Outcomes:

- **CO1 (Analyze):** Analyze market structures and consumer segmentation using data.
- **CO2 (Analyze):** Analyze brand preferences and buying behavior patterns.
- **CO3 (Apply):** Apply predictive models to consumer and campaign data.

- **CO4 (Apply):** Apply analytics for pricing, churn prediction, and recommendation systems.

Modules:

Module 1 – Introduction to Marketing Analytics (CO1) – 11 Hours
Overview of marketing data and KPIs, customer lifecycle analytics, customer segmentation, marketing mix modeling, basic statistical tools in consumer behavior.

Module 2 – Consumer Behavior and Segmentation (CO2) – 11 Hours
Buyer personas, RFM analysis, clustering techniques for consumer profiles, sentiment analysis, analysis of clickstream and transactional data.

Module 3 – Predictive Analytics in Marketing (CO3) – 12 Hours
Regression techniques, decision trees, lift charts, marketing funnel analytics, ROI measurement, lead scoring and sales conversion.

Module 4 – Advanced Topics in Consumer Analytics (CO4) – 11 Hours
Churn analysis, price optimization models, recommender systems, omni-channel strategy, personalization using machine learning, ethical use of consumer data.

Textbooks:

- Wayne L. Winston, *Marketing Analytics: Data-Driven Techniques with Microsoft Excel*, Wiley, 2021.
- Rajkumar Venkatesan, *Cutting Edge Marketing Analytics*, Pearson Education, 2020.

Reference Books:

- Stephan Sorger, *Marketing Analytics: Strategic Models and Metrics*, CreateSpace, 2013.
- Mike Grigsby, *Marketing Analytics: A Practical Guide to Real Marketing Science*, Kogan Page, 2018.

Web Resources:

- https://www.analyticsvidhya.com
- https://www.kaggle.com
- https://www.datacamp.com
- https://www.marketingcharts.com
- https://towardsdatascience.com

Course Code: DSC4024
Course Title: Multimodal Learning
L-T-P-C: 2-0-2-3
Type of Course: Program Core
Total Hours: 30 Hours Theory + 15 Weeks Lab
Course Description:
This course covers foundational and advanced concepts in multimodal learning, where models are trained on and infer from multiple data modalities (e.g., text, image, audio). It explores architectures, fusion techniques, alignment strategies, and real-world applications in AI.

Course Objectives:

- To understand the challenges of combining data from multiple modalities.
- To explore machine learning methods for multimodal representation learning.
- To implement models using fusion, alignment, and translation techniques.
- To apply multimodal systems to practical use cases.

Course Outcomes:

- **CO1 (Analyze):** Analyze multimodal data structures and relationships.
- **CO2 (Analyze):** Analyze fusion strategies for learning from multiple modalities.
- **CO3 (Apply):** Apply machine learning models for multimodal alignment and translation.
- **CO4 (Apply):** Apply deep learning architectures to solve real-world multimodal tasks.

Modules:

Module 1 – Introduction to Multimodal Learning (CO1) – 8 Hours

Modalities overview (vision, audio, text), challenges of heterogeneous data, early vs late fusion, joint representations, multimodal applications (e.g., VQA, speech-to-text).

Module 2 – Fusion and Representation Learning (CO2) – 7 Hours

Fusion strategies: concatenation, bilinear pooling, attention mechanisms. Shared representation learning, autoencoders, deep multimodal embeddings.

Module 3 – Alignment and Translation (CO3) – 7 Hours

Alignment tasks – image-text alignment, cross-modal retrieval. Multimodal translation – captioning, speech recognition. Metric learning and triplet loss.

Module 4 – Advanced Architectures and Applications (CO4) – 8 Hours

Transformers for multimodal tasks, BERT-like models for text+image. Case studies – healthcare, robotics, social media analytics, emotion detection.

Lab Experiments (15 Weeks)

1. Text and image preprocessing for multimodal input.
2. Fusion of tabular and image data.
3. Audio-visual dataset preparation.
4. Feature extraction using CNN and RNN.
5. Early vs late fusion implementations.
6. Image-caption alignment using attention.
7. Cross-modal retrieval.
8. Speech-to-text using pre-trained APIs.
9. Text-to-image generation using diffusion models.
10. Image classification with multimodal data.
11. Emotion detection using voice and facial cues.
12. Multimodal sentiment analysis.
13. Mini-project planning.
14. Mini-project implementation – phase 1.
15. Final presentation and evaluation.

Textbooks:

- Louis-Philippe Morency et al., *Multimodal Machine Learning: Techniques and Applications*, Cambridge University Press, 2023.
- Paul Michel, *Multimodal Transformers for Language Understanding*, Springer, 2022.

Reference Books:

- Jacob Devlin et al., *BERT and Beyond: Deep Language Understanding*, 2020.
- Andrej Karpathy, *Convolutional Neural Networks for Visual Recognition*, Stanford Notes.

Web Resources:

- https://paperswithcode.com
- https://huggingface.co
- https://www.analyticsvidhya.com

- https://arxiv.org/list/cs.MM/recent

Course Code: DSC4025
Course Title: Intelligent Decision Support Systems
L-T-P-C: 2-0-2-3
Type of Course: Program Core
Total Hours: 30 Hours Theory + 15 Weeks Lab
Course Description:
This course focuses on building intelligent systems that assist in decision-making using artificial intelligence, machine learning, and expert systems. Topics include knowledge-based systems, inference mechanisms, decision analysis models, and real-world applications.
Course Objectives:

- To understand the architecture of decision support systems.
- To apply AI methods for decision making.
- To evaluate multi-criteria decision analysis (MCDA).
- To develop intelligent support systems using real data.

Course Outcomes:

- **CO1 (Analyze):** Analyze decision problems using intelligent systems principles.
- **CO2 (Analyze):** Analyze decision support models for structured and unstructured data.
- **CO3 (Apply):** Apply AI and ML tools in decision-making applications.
- **CO4 (Apply):** Apply expert system concepts in intelligent DSS development.

Modules:
Module 1 – Foundations of Decision Support Systems (CO1) – 8 Hours
Definition and scope of DSS, types of decisions, decision-making processes, DSS architecture and components, DSS vs. MIS, introduction to intelligent DSS.
Module 2 – Knowledge-Based Decision Systems (CO2) – 7 Hours
Rule-based systems, inference engines, decision trees, fuzzy logic, uncertainty handling, introduction to expert systems, real-world applications.
Module 3 – Machine Learning in Decision Support (CO3) – 7 Hours
Regression and classification for decision support, ensemble models, clustering for customer segmentation, neural networks in DSS, feature selection, predictive modeling.
Module 4 – Multi-Criteria Decision Making and Advanced DSS (CO4) – 8 Hours
MCDA – AHP, TOPSIS, ELECTRE; real-time DSS, web-based DSS, recommendation engines, DSS in healthcare, finance, and logistics.
Lab Experiments (15 Weeks)

1. Explore DSS architecture through case study simulation.
2. Build a rule-based expert system using Python.
3. Design a decision tree classifier using scikit-learn.
4. Apply fuzzy logic to decision-making.
5. Develop a predictive model for customer churn.
6. Perform clustering for market segmentation.
7. Implement regression for price forecasting.
8. Integrate ML model in DSS dashboard.
9. Build a simple recommender system.
10. Apply AHP for decision ranking.

11. Apply TOPSIS to a real dataset.
12. Case study implementation (finance or healthcare).
13. Mini-project ideation and planning.
14. Mini-project development.
15. Mini-project presentation.

Textbooks:

- Efraim Turban et al., *Decision Support and Business Intelligence Systems*, Pearson, 10th Edition, 2020.
- George M. Marakas, *Decision Support Systems in the 21st Century*, Pearson, 2nd Edition, 2017.

Reference Books:

- V.S. Janakiraman and K. Sarukesi, *Decision Support Systems*, PHI, 2005.
- Ramesh Sharda et al., *Analytics, Data Science, & Artificial Intelligence: Systems for Decision Support*, Pearson, 2021.

Web Resources:

- https://towardsdatascience.com
- https://scikit-learn.org
- https://kdnuggets.com
- https://data-flair.training
- https://www.analyticsvidhya.com