Dr. Babasaheb Ambedkar Technological University (Established a University of Technology in the State of Maharashtra)
(Under Maharashtra Act No. XXIX of 2014)
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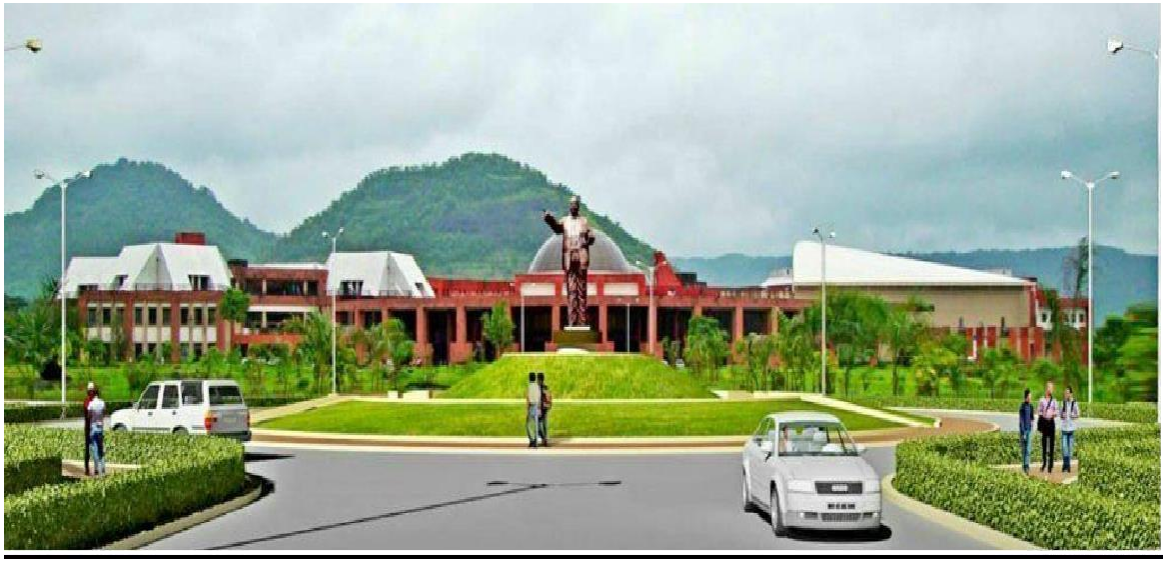
CURRICULUM UNDER GRADUATE PROGRAMME FOR B. TECH

ARTIFICIAL INTELLIGENCE & DATA SCIENCE

WITH EFFECT FROM THE ACADEMIC YEAR
SY: 2021-2022
TY: 2022-2023
B.Tech:2023-24



Rules and Regulations

1. The normal duration of the course leading to B. Tech degree will be EIGHT semesters.
2. The normal duration of the course leading to M. Tech. degree will be FOUR semesters.
3. Each academic year shall be divided into 2 semesters, each of 20 weeks duration, including evaluation and grade finalization, etc. The Academic Session in each semester shall provide for at least 90 Teaching Days, with at least 40 hours of teaching contact periods in a five to six days session per week. The semester that is typically from Mid-July to November is called the ODD SEMESTER, and the one that is from January to Mid-May is called the EVEN SEMESTER. Academic Session may be scheduled for the Summer Session/Semester as well. For 1st year B. Tech and M. Tech the schedule will be decided as per the admission schedule declared by Government of Maharashtra.
4. The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end- semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (Academic), and announced at least TWO weeks before the Closing Date of the previous Semester.
5. The Academic Calendar must be strictly adhered to, and all other activities including co-curricular and/or extra -curricular activities must be scheduled so as not to interfere with the Curricular Activities as stipulated in the Academic Calendar.

REGISTRATION:

1. Lower and Upper Limits for Course Credits Registered in a Semester, by a Full-Time Student of a UG/PG Programme: A full time student of a particular UG/PG programme shall register for the appropriate number of course credits in each semester/session that is within the minimum and maximum limits specific to that UG/PG programme as stipulated in the specific Regulations pertaining to that UG/PG programme.
2. Mandatory Pre-Registration for higher semesters: In order to facilitate proper planning of the academic activities of a semester, it is essential for the every institute to inform to Dean (Academics) and COE regarding details of total no. of electives offered (Course-wise) along with the number of students opted for the same. This information should be submitted within two weeks from the date of commencement of the semester as per academic calendar.
3. PhD students can register for any of PG/PhD courses and the corresponding rules of evaluation will apply.
4. Under Graduate students may be permitted to register for a few selected Post Graduate courses, in exceptionally rare circumstances, only if the DUGC/DPGC is convinced of the level of the academic achievement and the potential in a student.

Course Pre-Requisites:

1. In order to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior earned credits in, some specified courses.
2. Students who do not register on the day announced for the purpose may be permitted LATE REGISTRATION up to the notified day in academic calendar on payment of late fee.
3. REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the Dean (Academic) / Principal.

4. A student will be permitted to register in the next semester only if he fulfills the following conditions:

(a) Satisfied all the Academic Requirements to continue with the programme of Studies without termination

(b) Cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;

(c) Paid all required advance payments of the Institute and hostel for the current semester;

(d) Not been debarred from registering on any specific ground by the Institute.

EVALUATION SYSTEM:

1. Absolute grading system based on absolute marks as indicated below will be implemented from academic year 2020-21, starting from I year B. Tech.

Percentage of Marks	Letter Grade	Grade Point
91-100	EX	10.0
86-90	AA	9.0
81-85	AB	8.5
76-80	BB	8.0
71-75	BC	7.5
66-70	CC	7.0
61-65	CD	6.5
56-60	DD	6.0
51-55	DE	5.5
40-50	EE	5.0
<40	EF	0.0

2. Class is awarded based on CGPA of all eight semester of B. Tech Program.

CGPA < 6.50	Second Class
CGPA ≥ 6.50 & < 8.25	First Class
CGPA ≥ 8.25	Distinction
[Percentage of Marks =(CGPA-5)*10.0]	

3. A total of 100 Marks for each theory course are distributed as follows:

1	Mid Semester Exam (MSE) Marks	20
2	Continuous Assessment Marks	20
3	End Semester Examination (ESE) Marks	60

4. A total of 100 Marks for each practical course are distributed as follows:

1.	Continuous Assessment Marks	60
2.	End Semester Examination (ESE)Marks	40

It is mandatory for every student of B. Tech to score a minimum of 40 marks out of 100, with a minimum of 20 marks out of 60 marks in End Semester Examination for theory course.

This will be implemented from the first year of B. Tech starting from Academic Year 2020-21.

5. Description of Grades:

EX Grade: An 'EX' grade stands for outstanding achievement.

EE Grade: The 'EE' grade stands for minimum passing grade.

The students may appear for the remedial examination for the subjects he/she failed for the current semester of admission only and his/her performance will be awarded with EE grade only. If any of the student remain **absent** for the regular examination due to genuine reason and the same will be verified and tested by the Dean (Academics) or committee constituted by the University Authority.

FF Grade: The 'FF' grade denotes very poor performance, i.e. failure in a course due to poor performance .The students who have been awarded 'FF' grade in a course in any semester must repeat the subject in next semester.

6. Evaluation of Performance:

6.1. Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

(A) Semester Grade Point Average (SGPA) The performance of a student in a semester is indicated by Semester Grade Point Average (SGPA) which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SGPI is to be calculated up to two decimal places). A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$\text{SGPA} = \frac{\text{CREDIT INDEX}}{\sum \text{CREDITS for a Semester}}$$

Where

'n' is the number of subjects for the semester,

'ci' is the number of credits allotted to a particular subject, and

'gi' is the grade-points awarded to the student for the subject based on his performance as per the above table.

-SGPA will be rounded off to the second place of decimal and recorded as such.

(B) Cumulative Grade Point Average (CGPA): An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating Cumulative Grade Point Average (CGPA) of a student. The CGPA is weighted average of the grade points obtained in all the courses registered by the student since s/he entered the Institute. CGPA is also calculated at the end of every semester (upto two decimal places).Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$\text{CGPA} = \frac{\sum \text{CREDIT INDEX of all Previous Semester}}{\sum \text{CREDITS of all Previous Semester}} \text{ upto a Semester}$$

Where

'm' is the total number of subjects from the first semester onwards up to and including the semester S,

'ci' is the number of credits allotted to a particular subject, and

'gi' is the grade-points awarded to the student for the subject based on his/her performance as per the above table.

#CGPA will be rounded off to the second place of decimal and recorded as such.

Award of Degree of Honours

Major Degree

The concept of Major and Minors at B. Tech level is introduced ,to enhance learning skills of students, acquisition of additional knowledge in domains other than the discipline being pursued by the student, to make the students better employable with additional knowledge and encourage students to pursue cross-discipline research.

A. Eligibility Criteria for Majors

1. The Student should have Minimum CGPA of 7.5 up to 4th Semester
2. Student willing to opt for majors has to register at the beginning of 5th Semester
3. The Student has to complete 5 additional advanced courses from the same discipline specified in the curriculum. These five courses should be of 4 credits each amounting to 20 credits. The students should complete these credits before the end of last semester.
4. Student may opt for the courses from NPTEL/ SWAYAM platform. (if the credits of NPTEL/ SWAYAM courses do not match with the existing subject proper scaling will be done)

Student complying with these criteria will be awarded B. Tech (Honors) Degree.

B. Eligibility Criteria for Minors

1. The Student should have Minimum CGPA of 7.5 up to 4th Semester
2. Student willing to opt for minors has to register at the beginning of 5th Semester
3. The Student has to complete 5 additional courses from other discipline of their interest, which are specified in the respective discipline. These five courses should be of 4 credits each amounting to 20 credits.
4. Student may opt for the courses from NPTEL/ SWAYAM platform. (if the credits of NPTEL/ SWAYAM courses do not match with the existing subject proper scaling will be done)

Student complying with these criteria will be awarded with B. Tech Degree in------- Engineering with Minor in---------- Engineering.
(For e.g.: B. Tech in Artificial Intelligence & Data Science with Minor in Computer Engineering).

For applying for Honors and Minor Degree the student has to register themselves through the proper system.

ATTENDANCE REQUIREMENTS:

1. All students must attend every lecture, tutorial and practical classes.
2. To account for approved leave of absence (e.g. representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like Medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes actually conducted.
   a) If the student failed to maintain 75% attendance, he/she will be detained for appearing the successive examination.
   b) The Dean (Academics)/ Principal is permitted to give 10% concession for the

genuine reasons as such the case may be.

c) In any case the student will not be permitted for appearing the examination if the attendance is less than 65%.

3. The course instructor handling a course must finalize the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.

4. The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

TRANSFER OF CREDITS

The courses credited elsewhere, in Indian or foreign University/Institutions/ Colleges/ Swayam Courses by students during their study period at DBATU may count towards the credit requirements for the award of degree. The guidelines for such transfer of credits are as follows:

a) 20 % of the total credit will be considered for respective calculations.

b) Credits transferred will be considered for overall credits requirements of the programme.

c) Credits transfer can be considered only for the course at same level i. e UG, PG etc.

d) A student must provide all details (original or attested authentic copies)such as course contents, number of contact hours, course instructor /project guide and evaluation system for the course for which he is requesting a credits transfer. He shall also provide the approval or acceptance letter from the other side. These details will be evaluated by the concerned Board of Studies before giving approval. The Board of Studies will then decide the number of equivalent credits the student will get for such course(s) in DBATU. The complete details will then be forwarded to Dean for approval.

e) A student has to get minimum passing grades/ marks for such courses for which the credits transfers are to be made.

f) Credits transfers availed by a student shall be properly recorded on academic record(s) of the student.

g) In exceptional cases, the students may opt for higher credits than the prescribed.

B. Tech. in Artificial Intelligence & Data Science

Different Categories of Courses and Credits for Degree Requirements

a) Humanities and Social Science including Management Courses

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTHM104	Communication Skills	(2-0-0) 2
2	BTHM109L	Communication Skills Laboratory	(0-0-2) 1
3	BTHM403	Basic Human Rights	(3-0-0) 3
4	BTAIHM503	Knowledge Reasoning and AI Ethics.	(3-0-0) 3
5	BTAIHM605	(A) Development Engineering (B) Employability and Skills Development (C) Consumer Behavior (D) Economics and Management	(3-0-0) 3
6	BTAIHM706	(A) Foreign Language Studies (B) Universal Human Value & Ethics (C) Intellectual Property Rights	(0-0-2)Audit
		TOTAL	**12**

b) Basic Science Course

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTBS101	Engineering Mathematics – I	(3-1-0) 4
2	BTBS102	Engineering Physics	(3-1-0) 4
3	BTBS107L	Engineering Physics Laboratory	(0-0-2) 1
4	BTBS201	Engineering Mathematics-II	(3-1-0) 4
5	BTBS202	Engineering Chemistry	(3-1-0) 4
6	BTBS207L	Engineering Chemistry Laboratory	(0-0-2) 1
7	BTBS301	Engineering Mathematics-III	(3-1-0) 4
8	BTBS404	Probability Theory and Random Processes	(3-0-0) 3
		TOTAL	**25**

c) Engineering Science Course

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTES103	Engineering Graphics	(2-0-0) 2
2	BTES105	Energy and Environment Engineering	(2-0-0) 2
3	BTES106	Basic Civil and Mechanical Engineering	(2-0-0) Audit
4	BTES108L	Engineering Graphics Laboratory	(0-0-4) 2
5	BTES203	Engineering Mechanics	(2-1-0) 3
6	BTES204	Computer Programming	(2-0-0) 2
7	BTES205	Workshop Practices	(0-0-4) 2
8	BTES206	Basic Electrical and Electronics Engineering	(2-0-0) Audit
9	BTES208L	Engineering Mechanics Laboratory	(0-0-2) 1
10	BTES209L	Basic Computer Programming Laboratory	(0-0-2) 1
11	BTAIES304	Computer Architecture & Operating Systems	(3-0-0) 3
12	BTAIES305	Digital Logic & Signal Processing	(3-0-0) 3
		TOTAL	**21**

d) Professional Core Course

Sr. No.	Cours eCode	Course Name	(L-T-P) Credits
1	BTAIC302	An Introduction to Artificial Intelligence	(3-1-0) 4
2	BTAIC303	Data Structure and Algorithm using Python	(3-1-0) 4
3	BTAIC401	Data Analysis	(3-1-0) 4
4	BTAIC402	Database Management System	(3-1-0) 4
5	BTAIC501	Computer Network and Cloud Computing	(3-1-0) 4
6	BTAIC502	Machine Learning	(3-0-0) 3
7	BTAIC601	Deep Learning	(3-1-0) 4
8	BTAIC602	Advanced Machine Learning	(3-0-0) 3
9	BTAIC701	Natural Language Processing	(3-1-0) 4
10	BTAIC702	AIOPS	(3-0-0) 3
11	BTAIC703	Data Visualization and its tools	(3-1-0) 4
12	BTAIL306	Artificial Intelligence Lab and Programming, Data Structure and Algorithm using Python Lab	(0-0-4) 2
13	BTAIL406	Data Analysis Lab and Database Management System Lab	(0-0-4) 2
14	BTAIL506	Machine Learning Lab and Competitive Programming Lab	(0-0-4) 2
15	BTAIL606	Deep Learning Lab and Advanced Machine Learning Lab	(0-0-4) 2
16	BTAIL707	Natural Language Processing Lab & Data Engineering Lab	(0-0-4) 2
		TOTAL	**51**

e) Professional Elective Course

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTAIPE405	Professional Elective Courses –I 1. Numerical Methods and Computer Programming 2. Image Processing & Computer Vision 3. Internet of Things & Embedded System 4. Programming in JAVA	(3-1-0) 4
2	BTAIPE504	Professional Elective Course (PEC) -II 1. Virtual Reality 2. Soft Computing 3. Sensors & Robotics Technology 4. Advanced Java	(3-1-0) 4
3	BTAIPE603	Professional Elective Course (PEC) -III 1. Augmented Reality 2. Recommender System 3. Industry 4.0 & Automation 4. Web Development	(3-1-0) 4
4	BTAIPE704	Professional Elective Course (PEC) -IV 1. Time Series Forecasting 2. AIOPS 3. Autonomous Vehicle 4. Full Stack Development	(3-1-0) 4
		TOTAL	**16**

f) Open Elective Course

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTAIOE505	Open Elective Course (OEC) - I 1. Data Mining and Warehousing 2. Digital Communication & Information Theory 3. Software Engineering and Testing 4. Open Elective I	(3-1-0) 4
2	BTAIOE604	Open Elective Course (OEC) - III 1. Big Data Analytics 2. Cryptography & Network Security 3. Agile Methodology 4. Open Elective II	(3-1-0) 4
3	BTAIOE705	Open Elective Course (OEC) -IV 1. Data Science Optimization Techniques 2. Block chain Technology 3. Quantum Computing 4. Mobile Application Development	(3-1-0) 4
		TOTAL	**12**

g) Seminar / Mini Project / Internship

Sr. No.	Course Code	Course Name	(L-T-P) Credits
1	BTES210S	Seminar	(0-0-2) 1
2	BTES211P	Field Training / Internship / Industrial Training (minimum of 4 weeks which can be completed partially in first semester and second Semester or in at one time).	Audit
3	BTAIP408	Internship -II	Audit
4	BTAIP508	Internship –II (Evaluation)	Audit
5	BTAIP608	Internship -III	Audit
6	BTAIP709	Internship –III (Evaluation)	Audit
7	BTAIS307	Seminar-I	(0-0-4) 2
8	BTAIS407	Seminar-II	(0-0-4) 2
9	BTAIM507	Mini Project-I	(0-0-4) 2
10	BTAIM607	Mini Project-II	(0-0-4) 2
11	BTAIM708	Project Work	(0-0-4) 2
12	BTAIF801	Project Work / Internship	(0-0-24) 12
		TOTAL	**23**

Category – wise total number of credits

Sr. No	Category	Suggested Breakup of Credits by AICTE	Credits awarded to First year	Credits awarded to Second year to Final Year	Total
1	Humanities and Social Sciences including Management courses	**12***	3	9	**12**
2	Basic Science courses	**25***	18	7	**25**
3	Engineering Science courses including workshop, drawing, basics of electrical / mechanical / computer etc.	**24***	15	6	**21**
4	Professional core courses	**48***	0	51	**51**
5	Professional Elective courses relevant to chosen specialization/branch	**18***	0	16	**16**
6	Open subjects – Electives from other technical and /or emerging subjects	**18***	0	12	**12**
7	Project work, seminar and internship in industry or elsewhere	**15***	1	22	**23**
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Knowledge Tradition]	**NC**	--	--	**--**
	Total	**160***	**37**	**123**	**160**

**Minor variation is allowed as per need of the respective disciplines.*

Suggested Plan of Study

Number of Courses	Semester							
	I	II	III	IV	V	VI	VII	VIII
1	BTBS101	BTBS201	BTBS301	BTAIC401	BTAIC501	BTAIC601	BTAIC701	BTAIP801 (Project / Internship)
2	BTBS102	BTBS202	BTAIC302	BTAIC402	BTAIC502	BTAIC602	BTAIC702	--
3	BTES103	BTES203	BTAIC303	BTHM403	BTAIHM503	BTAIPE603 **(Elective)**	BTAIC703	--
4	BTHM104	BTES204	BTAIES304	BTBS404	BTAIPE504 **(Elective)**	BTAIOE604 **(Elective)**	BTAIPE704 **(Elective)**	--
5	BTES105	BTES205	BTAIES305	BTAIPE405 **(Elective)**	BTAIOE505 **(Elective)**	BTAIHM605 **(Elective)**	BTAIOE705 **(Elective)**	--
6	BTES106	BTES206	BTAIL306	BTAIL406	BTAIL506	BTAIL606	BTAIHM706 **(Elective)**	--
7	BTBS107L	BTBS207L	BTAIS307	BTAIS407	BTAIM507	BTAIM607	BTAIL707	--
8	BTES108L	BTES208L	BTES211P (Internship –1 Evaluation)	BTAIP408 (Internship –2)	BTAIP508 (Internship –2 Evaluation)	BTAIP608 (Internship –3)	BTAIP708	--
9	BTHM109L	BTES209S	--	--	--	--	BTAIP709 (Internship –3 Evaluation)	--
10	--	BTES211P (Internship -1)	--	--	--	--	--	--

Programme Educational Objectives (PEO)

Name of Programme: Bachelor of Technology (Artificial Intelligence and Data Science). A graduate in the discipline of Artificial Intelligence and Data Science is generally expected to have three kinds of knowledge. First, the graduate should have conceptual knowledge of the core topics of Computer Science. Second, she/he should have knowledge of mathematical formalism underlying various programming concepts. Third, graduates in the discipline of Artificial Intelligence and Data Science should have the knowledge of the state of the technologies and tools so that he/she can apply the principles of Artificial Intelligence and Data Science to solve real-life problems from diverse application domains. The programme of B.Tech in Artificial Intelligence and Data Science at Dr. Babasaheb Ambedkar Technological University (DBATU) essentially aims to meet these broad expectations. At the same time, the program intends to comply with the courses and syllabus available at National Program on Technology Enhanced Learning (NPTEL) and SWAYAM. The following specific educational objective aims to achieve these global and regional expectations**.**

Objective Identifier	Objectives
PEO1	To equip graduates with a strong foundation in engineering sciences and Artificial Intelligence and Data Science Engineering fundamentals to become effective collaborators, researchers and real-time problem solver with technical competencies.
PEO2	Perceive the limitation and impact of engineering solutions in social, legal, environmental, economic and multidisciplinary contexts.
PEO3	Excel in Industry/technical profession, higher studies, and entrepreneurship exhibiting global competitiveness

Programme Outcomes (PO)

After undergoing the learning process of four years, students of B.Tech. (Artificial Intelligence and Data Science) at Dr. Babasaheb Ambedkar Technological University will have an ability to build information systems and provide computer based solutions to real life problems. The graduates of this programme will demonstrate following abilities and skill sets.

Outcome Identifier	Outcomes
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

Outcome Identifier	Outcomes
PSO1	Apply the fundamentals of science, mathematics and engineering knowledge to design, development, formulates and investigate complex engineering problems related to application area in Artificial Intelligence and Data Science.
PSO2	Provide exposure to latest tools and technologies and aware of the impact of professional engineering solution in environmental, societal, professional ethics and able to communicate effectively.
PSO3	To publish research paper and think, innovates in artificial intelligence, machine Learning and Data Science domain

Graduate Attributes / ABET's Criteria

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These Graduate Attributes identified by National Board of Accreditation are as follows:

(a) Engineering knowledge: An ability to apply knowledge of mathematics, science and engineering.

(b) Problem analysis: An ability to design and conduct experiments as well as to analyze and interpret data.

(c) Design / development of solutions: An ability to design a system, a component, or process, to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

(d) Individual and team work: An ability to function on multidisciplinary teams.

(e) Problem Solving: An ability to identify, formulate and solve engineering problems.

(f) Ethics: An understanding of professional and ethical responsibility.

(g) Communication: An ability to communicate effectively.

(h) Environment and sustainability: The broad education necessary to understand the impact of engineeringsolutions in a global, economic, environmental and social context.

(i) Life-long learning: Recognition of the need for and an ability to engage in life-long learning.

(j) A knowledge of technology: Acknowledge of contemporary issues, and state of art technology

(k) Modern tool usage: An ability to use the techniques, skills, and modern engineering tools necessary forengineering practice.

(l) Project management and finance: Demonstrate knowledge and understanding of the engineering andmanagement principles and apply in multidisciplinary environments.

Mapping of Programme Outcomes with Graduate Attributes / ABET's Criteria

	A	B	C	D	E	F	G	H	I	J	K	L
PO1	X									X		
PO2		X			X							
PO3			X		X							
PO4			X		X							
PO5											X	
PO6					X					X		
PO7								X				
PO8						X						
PO9				X								
PO10							X					
PO11												X
PO12									X			

Course Structure for Second Year

B. Tech in Artificial Intelligence & Data Science

Semester III (Term 3)										
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credit
			L	T	P	CA	MSE	ESE	Total	
BSC7	BTBS301	Engineering Mathematics-III	3	1	-	20	20	60	100	4
PCC1	BTAIC302	An Introduction to Artificial Intelligence	3	1	-	20	20	60	100	4
PCC2	BTAIC303	Data Structure and Algorithm using Python	3	1	-	20	20	60	100	4
ESC11	BTAIES304	Computer Architecture & Operating Systems	3	-	-	20	20	60	100	3
ESC12	BTAIES305	Digital Logic & Signal Processing	3	-	-	20	20	60	100	3
LC1	BTAIL306	Artificial Intelligence Lab & Data Structure and Algorithm using Python Lab	-	-	4	60	-	40	100	2
Seminar	BTAIS307	Seminar-I	-	-	4	60	-	40	100	2
Internship	BTES211P	Internship –I (Evaluation)	-	-	-	-	-	-	-	Audit
			15	**3**	**8**	**220**	**100**	**380**	**700**	**22**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course HSSMC = Humanities and Social Science including Management Courses

Course Structure for Second Year

B. Tech in Artificial Intelligence & Data Science

Semester IV (Term 4)										
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				
			L	T	P	CA	MSE	ESE	Total	Credit
PCC3	BTAIC401	Data Analysis	3	1	-	20	20	60	100	4
PCC4	BTAIC402	Database ManagementSystem	3	1	-	20	20	60	100	4
HSSM C3	BTHM403	Basic Human Rights	3	-	-	20	20	60	100	3
BSC8	BTBS404	Probability Theory and Random Processes	3	-	-	20	20	60	100	3
PEC-1	BTAIPE405	Professional ElectiveCourses –I	3	1	-	20	20	60	100	4
	BTAIPE405A	1. Numerical Methods andComputer Programming								
	BTAIPE405B	2. Image Processing &Computer Vision								
	BTAIPE405C	3. Internet of Things &Embedded System								
	BTAIPE405D	4. Programming in JAVA								
LC2	BTAIL406	Data Analysis Lab and Database ManagementSystem Lab	-	-	4	60	-	40	100	2
Seminar	BTAIS407	Seminar - II	-	-	4	60	-	40	100	2
Internship	BTAIP408	Field Training / Internship / Industrial Training - II	-	-	-	-	-	-	-	Audit to be evaluate in V semester
			15	**3**	**8**	**220**	**100**	**380**	**700**	**22**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course HSSMC = Humanities and Social Science including Management Courses

Course Structure for Third Year

B. Tech in Artificial Intelligence & Data Science

Semester V (Term 5)									
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				
			L	T	P	CA	MSE	ESE	Total	Credit
PCC5	BTAIC501	Computer Network and Cloud Computing	3	1	-	20	20	60	100	4
PCC6	BTAIC502	Machine Learning	3	-	-	20	20	60	100	3
HSSMC4	BTAIHM503	Humanities and Social Sciences including Management Elective Course (HSSMEC) – II	3	-	-	20	20	60	100	3
	BTAIHM503A	1. Economics and Management								
	BTAIHM503B	2. Business Communication								
	BTAIHM503C	3. Knowledge Reasoning and AI Ethics.								
PEC-2	BTAIPE504	Professional Elective Course (PEC) -II	3	1	-	20	20	60	100	4
	BTAIPE504A	1. Advanced Database System								
	BTAIPE504B	2. Soft Computing								
	BTAIPE504C	3. Sensors & Robotics Technology								
	BTAIPE504D	4. Advanced Java								
OEC-1	BTAIOE505	Open Elective Course (OEC) - I	3	1	-	20	20	60	100	4
	BTAIOE505A	1. Data Mining and Warehousing								
	BTAIOE505B	2. Digital Communication & Information Theory								
	BTAIOE505C	3. Software Engineering and Testing								
	BTAIOE505D	4. Virtual Reality								
LC3	BTAIL506	Machine Learning Lab and Competitive Programming Lab	-	-	4	60	-	40	100	2
PROJ	BTAIM507	Mini Project I	-	-	4	60	-	40	100	2
Internship	BTAIP408	Field Training / Internship / Industrial Training – II(Evaluation)	-	-	-	-	-	-	-	Audit
			15	**3**	**8**	**220**	**100**	**380**	**700**	**22**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course HSSMC = Humanities and Social Science including Management Courses

Course Structure for Third Year
B. Tech in Artificial Intelligence & Data Science

Semester VI (Term 6)										
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				
			L	T	P	CA	MSE	ESE	Total	Credit
PCC7	BTAIC601	Deep Learning	3	1	-	20	20	60	100	4
PCC8	BTAIC602	Advanced Machine Learning	3	-	-	20	20	60	100	3
PEC-3	BTAIPE603	Professional Elective Course (PEC) -III	3	1	-	20	20	60	100	4
	BTAIPE603A	1. Geographical Information Systems								
	BTAIPE603B	2. Recommender System								
	BTAIPE603C	3. Industry 4.0 & Automation								
	BTAIPE603D	4. Web Development								
OEC-2	BTAIOE604	Open Elective Course (OEC) - I	3	1	-	20	20	60	100	4
	BTAIOE604A	1. Big Data Analytics								
	BTAIOE604B	2. Cryptography & Network Security								
	BTAIOE604C	3. Agile Methodology								
	BTAIOE604D	4. Augmented Reality								
HSSMEC-5	BTAIHM605	Humanities and Social Sciences including Management Elective Course (HSSMEC) – II	3	-	-	20	20	60	100	3
	BTAIHM605A	1. Development Engineering								
	BTAIHM605B	2. Employability and Skills Development								
	BTAIHM605C	3. Consumer Behavior								
LC4	BTAIL606	Deep Learning Lab and Advanced Machine Learning Lab	-	-	4	60	-	40	100	2
PROJ	BTAIM607	Mini Project II	-	-	4	60	-	40	100	2
Internship	BTAIP608	Field Training / Internship / Industrial Training - III	-	-	-	-	-	-	-	Audit to be evaluated in VII semester
			15	**3**	**8**	**220**	**100**	**380**	**700**	**22**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course HSSMC = Humanities and Social Science including Management Courses

Course Structure for Final Year
B. Tech in Artificial Intelligence & Data Science

Semester VII (Term 7)										
Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				
			L	T	P	CA	MSE	ESE	Total	Credit
PCC9	BTAIC701	Natural Language Processing	3	1	-	20	20	60	100	4
PCC10	BTAIC702	Advanced Computer Vision	3	1	-	20	20	60	100	4
PCC11	BTAIC703	Data Engineering	3	-	-	20	20	60	100	3
PEC-4	BTAIPE704	Professional Elective Course (PEC) -IV	3	1	-	20	20	60	100	4
	BTAIPE704A	1. Time Series Forecasting								
	BTAIPE704B	2. AI Operations								
	BTAIPE704C	3. Autonomous Vehicle								
	BTAIPE704D	4. Full Stack Development								
OEC-3	BTAIOE705	Open Elective Course (OEC) – III	3	1	-	20	20	60	100	4
	BTAIOE705A	1.Data Science Optimization Techniques								
	BTAIOE705B	2. Block chain Technology								
	BTAIOE705C	3. Quantum Computing								
	BTAIOE705D	4. Mobile Application Development								
HSSMEC -6	BTAIHM706	Humanities and Social Sciences including Management Elective Course (HSSMEC) – II	-	-	2	-	-	-	-	Audit
	BTAIOE706A	1. Foreign Language Studies								
	BTAIOE706B	2. Universal Human Value & Ethics								
	BTAIOE706C	3. Intellectual Property Rights								
LC5	BTAIL707	Natural Language Processing & Data Engineering Lab	-	-	4	60	-	40	100	2
PROJ	BTAIM708	Project Work	-	-	4	60	-	40	100	2
Internship	BTAIP608	Field Training / Internship / Industrial Training – III (Evaluation)	-	-	-	-	-	-	-	Audit
			15	**4**	**10**	**220**	**100**	**380**	**700**	**23**

Semester VIII (Term 8)										
Course Category	Couse Code	Course Title	Teaching Scheme			Evaluation Scheme				
			L	T	P	CA	MSE	ESE	Total	Credit
Project/ Internship	BTAIF801	Project Work/ Internship	-	-	24	60	-	40	100	12
			-	**-**	**24**	**60**	**-**	**40**	**100**	**12**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course HSSMC = Humanities and Social Science including Management Courses

Second Year (Semester –III)

Engineering Mathematics-III

BTBS301	Engineering Mathematics-III	BSC7	3L- 1T -0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. To study the concepts of transformations, used in various field of artificial intelligence and data science.
2. To study partial differential equations to apply it in computer and electronics engineering.
3. To use complex variables.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Understand the concept of LT & ILT.
CO2	Solve problems related to Fourier transform to Deep Learning, Signal & Image processing.
CO3	Understand the concepts of linear algebra and apply Linear Programming, Computer Graphics and Cryptography.
CO4	Understand the concepts of PDE and apply it in data analysis.
CO5	Analyze function of complex variables.

Course Contents:

Unit 1: Laplace Transform **[07 Hours]**

Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by t^n, scale change property, transforms of functions divided by t, transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac delta function.

Unit 2: Inverse Laplace Transform **[07 Hours]**

Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding inverse Laplace transforms ; Applications to find the solutions of linear differential equations and simultaneous linear differential equations with constant coefficients.

Unit 3: Fourier Transform **[07 Hours]**

Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ;Complex form of Fourier integrals ; Fourier sine and cosine transforms; Properties of Fourier transforms ; Parseval's identity for Fourier Transforms.

Unit 4: Partial Differential Equations and Their Applications **[09 Hours]**

Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange's linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$ and one dimensional wave equation (i.e. $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$).

Unit 5: Functions of Complex Variables **[08 Hours]**

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form; Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs)

Text Books

1. Linear Algebra, Seymour Lipschutz, Schaums outlines, 4th Edition, McGraw-Hill Publication.

Reference Books

1. Introduction to Linear Algebra, Gilbert Strang, 5th Edition, Wellesley-Cambridge Press.
2. K. Hoffman and R. Kunze, Linear Algebra, 2nd Edition, Prentice-Hall of India, 2005.
3. M. Artin, Algebra, Prentice-Hall of India, 2005.

Second Year (Semester –III)

An Introduction to Artificial Intelligence

BTAIC302	An Introduction to Artificial Intelligence	PCC1	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. To provide a strong foundation of fundamental basics of Artificial Intelligence.
2. Demonstrate awareness and fundamental understanding of various applications of AI techniques.
3. Apply Artificial Intelligence techniques for problem solving.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Discuss Meaning, Scope and Stages of Artificial Intelligence
CO2	Understand and Implement Problem Space and Search Strategies for Solving problems.
CO3	Discuss the Search Techniques and Knowledge Representation.
CO4	Apply search for solving Constraint Satisfaction Problems and Game-playing.
CO5	Discover the Application of Artificial Intelligence and Analyze Impact of AI on Society

Course Contents:

Unit No 1: Introduction: [7 Hours]

What Is AI? The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art. Introduction: Philosophy of AI, Definitions, AI Future. Stages of AI. (ANI, AGI ASI with examples).

Intelligent Agents: Agents and Environments Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

Unit No 2: Search Methods [8 Hours]

State Space Search

Generate and test, simple search, Depth first search (DFS), Breadth First search (BFS), Comparison, Quality of Solution, Depth Bounded DFS, Depth First Iterative Deepening.

Heuristic Search:

Heuristic Functions, Search Techniques: Best-first search, Hill climbing, Local Maxima, Solution Space Search, Variable Neighbourhood Descent, Beam Search, Tabu Search, Peak to peak method.

Unit No 3: Randomized Search: [7 Hours]

Population Based Methods: Escaping Local Optima, Iterated Hill Climbing, Simulated Annealing, Genetic Algorithms, Neural Network, Emergent Systems, Ant Colony Optimization.

Unit No 4: Optimal Path Finding [7 Hours]

Brute Force, Branch & Bound, Refinement Search, Dijkstra Algorithm, Algorithm A*, Admissible A*, Iterative Deepening A*, Recursive Best First Search, Pruning the CLOSED List, Pruning the OPEN List, Conquer Beam Stack Search.

Unit No 5: Constraint Satisfaction [7 Hours]

N Queens, Constraint Propagation, Scene labelling, Higher order consistency, Algorithm backtracking, Look-head strategies, Strategic retreat.

Text Books

1. Deepak Khemani, “A First Course in Artificial Intelligence”, McGraw-Hill Education, 2013.
2. Eugene, Charniak, Drew Mcdermott, "Introduction to artificial intelligence", Addison Wesley, 1985.
3. Elaine Rich, Kevin Knight, Shivashankar B Nair:Artificial Intelligence, Tata CGraw Hill 3rd edition. 2013.
4. Stuart Russel, Peter Norvig: Artificial Intelligence A Modern Approach, Pearson 3rd edition 2013.

Reference Books

1. Peter Norvig, Artificial Intelligence: A Modern Approach, Third Edition.
2. Herbert A. Simon, "The Sciences of the Artificial ", MIT Press, 3rd Edition (2nd Printing), 1995. 3. Tim Jones, "Artificial Intelligence Application Programming", Dreamtech Publication.
3. George F. Luger, “Artificial Intelligence-Structures and Strategies For Complex Problem Solving”, Pearson Education / PHI, 2002.
4. Prolog Programming for A.I. by Bratko, TMH

Semester –III

Data Structure and Algorithm Using Python

BTAIC303	Data Structure and Algorithm Using Python	PCC2	3L-1T-0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Introduce the fundamental concept of Python programming to the students
2. Understand various data structures in Python and write algorithms and programs using them
3. Compare alternative implementations of data structures with respect to performance
4. Discuss the computational efficiency of the principal algorithms for sorting, searching, and hashing

Course Outcomes:

On completion of the course, students will be able to:

CO1	Write programs using basic concepts of Python Programming
CO2	Implement algorithms for arrays, linked structures, stacks, queues, trees, and graphs
CO3	Write programs that use arrays, linked structures, stacks, queues, trees, and graphs
CO4	Compare and contrast the benefits of dynamic and static data structures implementation
CO5	Discuss the computational efficiency of the principal algorithms for sorting, searching, and hashing

Course Contents:

Unit 1: Introduction to Programming **[07 Hours]**

Introduction to Programming, Why Programming, What is a Program? Problem Solving, Algorithms and Data Structure

Introduction to Programming, Variables, Data Types, Input-Output Statements, Indentation, Operators- Arithmetic Operators, Comparison (Relational) Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Expressions and order of evaluations.

Control Flow- if, if-elif-else, for, while break, continue, pass

Collections- String, Lists, Tuples, Dictionaries, Sets, Map

Unit 2: Functions & Object Oriented Programming using Python [07 Hours]

Functions- Built-in and User defined functions, Default Arguments, Variable-length arguments, Anonymous Functions, Fruitful Functions (Function Returning Values), Scope of the Variables in a Function- Global and Local Variables, Recursions

Need for OOP, Classes and Objects, OOP Concepts, Constructor, Class Diagram, Encapsulation, Statics, Relationship, Inheritance, and Abstract Classes, Exception Handling

Unit 3: Data Structures in Python [07 Hours]

ADT- Defining the ADT, Using the ADT, Pre conditions and post conditions

Introduction to Data Structures, Types of Data Structures, Arrays- Need for array, Array ADT, Implementing array, 2-D arrays,

Linked Structures- Singly Linked List & Operations with algorithms, Application- Polynomials, Doubly Linked Lists, Circular Linked List

Stacks- Stack ADT, Implementing the stack- using Python List and using a linked list, Stack Applications- Evaluating Postfix expressions

Queues- Queue ADT, Implementing the queue- using Python List and using a linked list, Priority Queue, Applications of Queues

Unit 4: Non-Linear Data Structures in Python [07 Hours]

Binary Trees- Tree Structure, Properties, Implementation, Tree Traversals, Heaps-Definition, Implementation, Heap Sort

Binary Search Trees- Operations and Algorithms (searching, insertion, deletion, min, max),

Hash Tables- Hashing techniques, Hash functions, Applications

Unit 5: Searching & Sorting Algorithms and Analysis [08 Hours]

Search Algorithms- Linear Search Algorithm, Binary Search Algorithm,

Comparison Sort Algorithms- Introduction, Selection Sort, Insertion Sort, Bubble Sort, Merge Sort, Quick Sort

Algorithmic Techniques-Algorithm Technique- Greedy Approach, Dynamic Programming,

Complexity Analysis of Algorithms- Introduction, Analysis of Algorithms, Big-O Notation, Evaluating the Python List.

Text Books / Reference Books

1. Data Structures and Algorithms Using Python, Rance D. Necaise
2. Python for Everybody, Exploring Data Using Python 3, Dr. Charles R. Severance
3. Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser.

Semester –III

Computer Architecture and Operation Systems

BTAIES304	**Computer Architecture and Operation Systems**	**ESC11**	**3L-0T-0P**	**3 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. To understand the structure, function and characteristics of computer systems
2. To identify the elements of modern instructions sets and their impact on processor design
3. To understand the services provided by and the design of an operating system.
4. Understand the structure, organization memory management.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Understand the theory and architecture of central processing unit & Analyze some of the design issues in terms of speed, technology, cost, performance
CO2	Use appropriate tools to design verify and test the CPU architecture & Learn the concepts of parallel processing, pipelining and inter processor communication.
CO3	Understand the architecture and functionality of central processing unit & Exemplify in a better way the I/O and memory organization, Memory management systems, Virtual Memory
CO4	Describe and explain the fundamental components of a computer operating system
CO5	Define, restate, discuss, and explain the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.

Course Contents:

Unit 1: Introduction, Arithmetic and Instruction Sets [07 Hours]

Introduction: Concept of computer organization and architecture, Fundamental unit, Computer function and interconnection, CPU structure and function.

Computer Arithmetic: The arithmetic and logic Unit, Integer representation, Integer arithmetic, Floating point representation, Floating point arithmetic, Introduction of arithmetic co-processor.

Instruction Sets: Characteristics, Types of operands, Types of operations, Assembly language, Addressing modes, Instruction format, Types of instruction, Instruction execution, Machine state and processor status, Structure of program, Introduction to RISC and CISC architecture.

Unit 2: Memory Organization and Management [8 Hours]

Memory Organization: Internal Memory: Semiconductor main memory, Error correction, Advanced DRAM organization, Virtual memory systems and cache memory systems. External Memory: Organization and characteristics of magnetic disk, Magnetic tape, Optical memory, RAID, Memory controllers.

Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Continuous Memory Allocation, Fixed and variable partition, Internal and external fragmentation and

compaction, Paging: Principle of operation, Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging.

Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).

Unit 3: Control Unit & Input/ Output Organization: [07 Hours]

Control Unit: Control unit operation: Micro-operations, Control of the processor, Hardwired implementation, Micro-programmed Control Unit, Basic concepts, Micro-instruction sequencing, Micro-instruction execution, Applications of micro-programming.

Input/ Output Organization: External devices, I/O module, Programmed I/O, Interrupt driven I/ O, Direct memory access, I/O channels and processors, External interface. Instruction pipe-lining: Concepts. Parallel processing: Multiple processor organization, Symmetric multiprocessor, Cache coherence and the MESI protocol.

Unit 4: Introduction OS & Processes and CPU Scheduling: [07 Hours]

Introduction and Operating system structures: Definition, Types of Operating system, Real Time operating system, System Components- System Services, Systems Calls, System Programs, System structure. Virtual Machines, System Design and Implementation, System Generations.

Processes and CPU Scheduling: Process Concept, Process Scheduling, Operation on process, Cooperating processes. Threads, Inter-process Communication, Scheduling criteria, scheduling Algorithms, Multiple-Processor Scheduling, Real-Time Scheduling, Scheduling Algorithms and performance evaluation.

Unit 5: Process Synchronization & Deadlocks [07 Hours]

Process Synchronization: The critical-section problem, Critical regions, Synchronization Hardware, Semaphores, Classical Problems of synchronization, and Monitors Synchronizations in Solaris.

Deadlocks: Systems Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock, Combined approach to deadlock Handling.

Text Books

1. William Stalling, Computer Organization and Architecture: Designing for Performance, Prentice Hall Publication, 8th Edition, 2009.
2. Hayes, Computer Architecture and Organization, McGraw-Hill Publication, 3rd Edition, 2012.
3. Zaky, Computer Organization, McGraw-Hill Publication, 5th Edition, 2011
4. Andrew S. Tanenbaum, Modern Operating System, PHI Publication, 4th Edition, 2015.

Reference Books

1. Hennessy and Patterson, Computer Architecture: A Quantitative Approach, Morgan and Kaufman Publication, 4th Edition, 2007.
2. Morris Mano, Computer System Architecture, Pearson Education India, 3rd Edition, 2007.
3. Mostafa Abd-El-Barr, Hesham El-Rewini, Fundamentals of Computer Organization and Architecture, Wiley Publication, 1st Edition, 2004.

Semester –III

Digital Logic & Signal Processing

BTAIES305	Digital Logic & Signal Processing	ESC12	3L-0T-0P	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. To acquaint the students with the fundamental principles of two-valued logic and various devices used to implement logical operations on variables.
2. To classify signals and systems into different categories.
3. To analyze Linear Time Invariant (LTI) systems in time and transform domains.
4. To build basics for understanding of courses such as signal and image processing, computer vision, Machine Learning and Deep Learning.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Use the basic logic gates and various reduction techniques of digital logic circuit in detail
CO2	Understand mathematical description and representation of various signals and systems.
CO3	Develop input output relationship for linear shift invariant system and understand the convolution operator for discrete time system.
CO4	Understand use of different transforms and analyze the discrete time signals and systems.
CO5	Understand the concept of correlation, regression and spectral density.

Course Contents:

Unit 1: Number System and Boolean Algebra [07 Hours]

Digital Signal, Digital logic circuits: AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR.

Boolean algebra and theorems.

Number System: Binary, Octal, Decimal, and Hexadecimal. Binary Arithmetic (addition, subtraction, multiplication, division), 1's & 2's compliment.

Codes: Binary, Gray, BCD, Excess-3, Octal, Hexadecimal code.

Unit 2: Introduction to Signals and Systems [8 Hours]

Signals: Definition of signal and systems, Continuous time and discrete time signal,

Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power, elementary signals used for testing: exponential, sine,

impulse, step and its properties, ramp, rectangular, triangular, signum, sinc.

Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration (Accumulator for DT), time scaling, time shifting and time folding. Sampling Process.

Systems: Definition, Classification: linear and non-linear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.

Unit 3: Discrete Fourier Transform [07 Hours]

DTFT, Definition, Frequency domain sampling, DFT, Properties of DFT, Convolution: circular convolution, linear convolution, FFT, decimation in time and decimation in frequency using Radix-2 FFT algorithm.

Unit 4: Z transform [07 Hours]

Need for transform, relation between Laplace transform and Z transform, between Fourier transform and Z transform, Properties of ROC and properties of Z transform, Inverse Z transform, Power series method, partial fraction expansion method, Solution of difference equations.

Unit 5: Correlation and Spectral Density [07 Hours]

Introduction of correlation and correlogram, the correlation function: analogy between correlation and convolution, auto-correlation, properties of auto-correlation, Cross-correlation: properties of cross correlation

Introduction of Spectral density, ESD, Properties of ESD, PSD, Properties of PSD.

Text Books

1. Dr. S. L. Nalbalwar, A.M. Kulkarni and S.P. Sheth, “Signals and Systems”, 2nd Edition, Synergy Knowledgeware,2017
2. Nagoor Kanni “Signals and Systems”, 2nd edition, McGrawHill.

Reference Books

1. R. P. Jain, Modern digital electronics. 3rd edition, 12threprint Tata McGraw Hill Publication,2007.
2. Alan V. Oppenheim. Alan S. Willsky and S. Hamid Nawab, “Signals and Systems”,PHI
3. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
4. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms And Applications, Prentice Hall, 1997.
5. S.K.Mitra, Digital Signal Processing: A computer based approach.TMH
6. ShailaApte, “Signals and Systems-principles and applications”, Cambridge University press,2016.

Semester –III

An Introduction to Artificial Intelligence Lab and Data Structure and Algorithm Using Python Lab

BTAIL306	**Artificial Intelligence Lab and Data Structure and Algorithm Using Python Lab**	**LC1**	**0L-0T-4P**	**2 Credits**

Teaching Scheme	**Examination Scheme**
Practical: 04 hrs./week	Continuous Assessment 1: 30 Marks Continuous Assessment 2: 30 Marks End Semester Examination: 40 Marks

A) Artificial Intelligence Lab

List of Practical/Tutorial

Software Tools: Programming languages, namely Java, Python, C++, Lisp, and Prolog, is highly recommended for students to use when completing their assignments and/or practical's for this course.

1. Study of Java/Python/C++/ Lisp/ PROLOG.
2. Existing AI Application (e.g. Recommendation system, Carpooling, OTT channels etc.)
3. Solve any problem using depth first search.
4. Solve any problem using breadth first search.
5. Solve 8-puzzle problem using best first search.
6. Write a program to solve Tic-Tac-Toe using Min-Max search.
7. Solve traveling salesman problem.
8. Write a program for Alpha–Beta Pruning.
9. Write a program to solve 8 queens problem.
10. Write a program to solve map coloring problem using CSP.

Note:

1. Open Source tools and technology use for programs
2. Lab should be in scope of hands of experience and practice related program must
3. Add case study and Live project experience if any related contents

Software Tools: Programming languages Python and Opens Source tools must and highly recommended for students to use when completing their assignments and/or practical's for this course.

B) Data Structure and Algorithm Using Python Lab

List of Practical

Downloading and installing Python gcd in Python as start of lab for hands on laboratory

1) Write code and understand the concept Variable, Data Type and Data Object in python.
2) Write code and understand the concept List, Tuple, and Array in python.
3) Write code and understand the concept Loop and Function in python.
4) Write code and understand the concept Classes and Objects in python.
5) Write code and understand the concept Constructor and Relationship
6) Write code and understand the concept Inheritance and Exception Handling in python.
7) Write code and understand the concept List in data Structure
8) Write code and understand the concept Queue in data Structure
9) Write code and understand the concept Array in data Structure
10) Write code and understand the concept Graphs, Trees in data Structure
11) Write code and understand the concept Hashing, Hast Tables in data Structure
12) Write code and understand the concept Search Algorithms (Any two)
13) Write code and understand the concept Sorting Algorithms (Any two)
14) Write code and understand the concept Algorithm Technique on Greedy Approach

Note:

1. Open Source tools and technology use for programs
2. Lab should be in scope of hands of experience and practice related program must
3. Add case study and Live project experience if any related contents

Semester –III
Seminar-I

BTAIS307	**SEMINAR- I**	**Seminar**	**0L-0T-4P**	**2 Credits**

Guidelines for Seminar

The students shall study in group of two members (or individual) on some special topic beyond the scope of the syllabus under the subjects of Artificial Intelligence, Data Science, Electronics Engineering and Computer Science Engineering or inter discipline branch from current literature, by referring the current technical journal or reference books, under the guidance of the teacher. The students shall prepare his report and deliver talk on the topic for other students of his class in the presence of his guide and internal examiner. The student is permitted to use audio-visual aids or any other such teaching aids.

Continues Assessment:

The Continues Assessment for this head will consists of the report written in a technical reporting manner and presentation of the talk on the subject and will be assessed by the internal examiner appointed by the HOD of concern department of the institution.

Semester –III
Internship - I

BTES211P	**Field Training / Internship / Industrial Training**	**Internship**	**Audit**

Guidelines for Internships

Guidelines for Field Training / Internship / Industrial Training Industrial Training:

1. To apply for a suitable Industrial Training, submit an application form to respective Organization concerned one semester before the Industrial Training Programmed commences.
2. Student can also apply through online platforms such as Internshala for industrial training.
3. Submit one copy of the offer letter for the Industrial Training to the Head of the department or Faculty coordinator (Industrial Training).
4. To complete the Industrial Training process within the specified time based on the Industrial Training Programme schedule.
5. Assessment within the Industrial Training context aims to evaluate the student's work quality and appropriateness to the field of study with reference to the learning outcomes of the Industrial Training Programme.
6. Evaluation of the students' performance should be done in the next upcoming semester.
7. Those students who fails, they can also complete online certification courses which are available at free of cost on various MOOC platforms.

Semester –IV

Data Analysis

BTAIC401	Data Analysis	PCC3	3L - 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Basics of Linear Algebra, Introduction, Probability and Statistics.

Course Objectives:

After completion of the course, students will learn:-

1. To obtain a Comprehensive knowledge of various tools and techniques for Data transformation and visualization
2. To learn the probability and probabilistic models of data science
3. To learn the basic statistics and testing hypothesis for specific problems
4. To learn about the prediction models
5. To give a hands-on experience with real-world data analysis

Course Outcomes:

On completion of this course, the student should be able to

CO1	Apply preprocessing techniques to convert raw data so as to enable further analysis
CO2	Apply exploratory data analysis and create insightful visualizations to identify patterns
CO3	Understand how to derive the probability density function of transformations of random variables and use these techniques to generate data from various distributions
CO4	Understand the statistical foundations of data science and analyze the degree of certainty of predictions using statistical test and models
CO5	Introduce machine learning algorithms for prediction and to derive insights

Course Contents:

Unit 1: Statistical data and Concepts [07 Hours]

The statistical Methods, Misuse, Misinterpretation and bias, Sampling and sampling size, Data preparation and cleaning, Missing data and data errors, Exploratory Data Analysis, Statistical error, Statistical Modeling, Computational Statistics, Inference, Bias, Cofounding, Hypothesis testing, Types of error, Statistical significance, Confidence Interval, Power and robustness, Degrees of freedom, Non parametric analysis.

Unit 2: Descriptive Statistics [07 Hours]

Counts and specific values, Measure of central tendency, Measure of spread, Measure of distribution shape, Statistical indices, Moments, Key functions, Measures of complexity and model selection.

Unit 3: Data transformation and standardization **[07 Hours]**

Box-Cox and power transforms, Freeman-Tukey (square root and arcsine) transforms, Log and Exponential transforms, Logit transforms, Normal transform.

Unit 4: Classical Tests and Contingency Tables **[7 Hours]**

Goodness of fit tests: Anderson-Darling, Chi-square test, Kolmogorov-Smirnov, Ryan-Joiner, Shapiro-Wilk, Jarque-Bera, Lilliefors;

Z- test: test of single mean, standard deviation known, Test of the difference between two means, standard deviation known, test for proportions, P;

T-tests: test of single mean, standard deviation not known, Test of the difference between two means, standard deviation not known, test of regression coefficients;

Unit 5: Analysis of Variance and Covariance **[08 Hours]**

Variance test: Chi square test of single variable, F-test of two variables, test of homogeneity; Wilcoxon rank-sum/Mann-Whitney U test; Sign test.

Contingency Tables: Chi-square contingency table test, G contingency table test, Fisher's exact test, Measures of association, McNemar's test.

ANOVA: Single factor or one way ANOVA, Two factor or two-way and higher-way ANOVA, MANOVA, ANCOVA; Non Parametric ANOVA: Kruskal Wallis ANOVA, Friedam ANOVA test, Mood's median

Text Books

1. Dr. Michael J de Smith, Statistical Analysis Handbook, A Comprehensive guide to statistical concepts methods and tools, The Winchelsea Press, Drumlin Security Ltd, Edinburgh 2018 edition. https://www.statsref.com/HTML/index.html
2. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, Sixth Edition, Wiley, 2013
3. Dr.J.Ravichandran, Probability And Statistics For Engineers, First Edition, Wiley, 2010 Scientists

Reference Books

1. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014. (free online)
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. ISBN 0262018020. 2013.
3. Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.
4. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.

Semester –IV

Database Management System

BTAIC402	Database Management System	PCC4	3L-1T-0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Fundamentals of Database Management Systems and types of DBMS used in data analysis
2. Understand various ways to organize, maintain and retrieve - efficiently, and effectively – information from different DBMS
3. Design and maintenance of the database systems
4. Discuss the computational efficiency of the principal algorithms for sorting, searching, and hashing

Course Outcomes:

On completion of the course, students will be able to:

CO1	Master the basic concepts of relational DBMS and its types.
CO2	Perform various types of operations on relational databases using DDL, DML, DCL in SQL
CO3	Understand the concept of how non-relational databases differ from relational databases from a practical perspective.
CO4	Master the basic concepts of designing NoSQL database management system.
CO5	Able to Identify what type of NoSQL database to implement based on business requirements

Course Contents:

Unit 1: Introduction to Databases **[06 Hours]**

Introduction to Data and Database, Significance of Database Management System, Various Types of DBMS- relational & non-relational, Data Independence - The Three Levels Of Architecture - The External Level - Conceptual Level - Internal Level - Client/Server Architecture- System Structure , Instance and schema

Unit 2: Relational Database Management System [07 Hours]

Data Models & Types, ER to Relational Mapping , Structure Of Relational Databases, Creation and Manipulation of Database using Basic SQL(DDL, DML,DCL,TCL)

Normalization –Anomalies- Functional Dependency, Normal forms- 1NF, 2NF, 3NF, Boyce - Codd Normal Form

Unit 3: Non-Relational Database Management System [07 Hours]

NOSQL Systems-Introduction to NoSQL, Disadvantages of NoSQL technology, NOSQL Systems, weakness of RDBMS, CAP theorem, Types of NoSQL Databases,

Key-value database-Key values database, More elements of key values database, Properties of Key-value store, Redis implementation (Basic CRUD operation)

Unit 4: Columnar & Document Databases [8 Hours]

Columnar Databases with Apache Cassandra- Characteristics of a columnar database,

Concepts of columnar databases, Cassandra Introduction and its use-cases, implement a columnar database using Apache Cassandra

Introduction to Document databases, Document databases with MongoDB - Implement a document database with MongoDB

Unit 5: Graph and Future databases [8 Hours]

Graph Databases - Graph databases, graph traversal and graph problems, graph data structures edge list, adjacency matrix, properties of graph model.

Implementation and systems - Reliable, maintainable and scalable, Different information systems, NEO4J implementation (Basic CRUD operation), Introduction to Advance Databases- PostgreSQL

Text Books

1. Abraham Silberchatz, Henry K.Forth, Sudharshan, "Database system Concepts" – (6th edition), McGraw Hill, 2010.

2. Guy Harrison, "Next Generation Databases", Apress, 2015.

3. Eric Redmond, Jim R Wilson, "Seven Databases in Seven Weeks", LLC. 2012

Reference Books

1. K. Pakhira, "Database Management System", Phi Learning Pvt. Ltd., 2012

2. MongoDB: The Definitive Guide, 2nd Edition , Powerful and Scalable Data Storage, By Kristina Chodorow, Publisher: O'Reilly Media

3. MongoDB Basics - EelDavid Hows,Peter Membrey,coPlugge, Publisher Apress - Ebook(free) https://it-ebooks.info/book/4527/

Semester –IV

Basic Human Rights

BTHM403	**Basic Human Rights**	**HSSMC3**	**3L- 0T -0P**	**3 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

1. To train the young minds facing the challenges of the pluralistic society and the rising conflicts and tensions in the name of particularistic loyalties to caste, religion, region and culture.
2. To give knowledge of the major "signposts" in the historical development of human rights, the range of contemporary declarations, conventions, and covenants.
3. To enable them to understand the basic concepts of human rights (including also discrimination, equality, etc.), the relationship between individual, group, and national rights.
4. To develop sympathy in their minds for those who are denied rights.
5. To make the students aware of their rights as well as duties to the nation

Course Outcomes:

On completion of the course, students will be able to:

CO1	Students will be able to understand the history of human rights.
CO2	Students will learn to respect others caste, religion, region and culture.
CO3	Students will be aware of their rights as Indian citizen.
CO4	Students will be able to understand the importance of groups and communities in the society.
CO5	Students will be able to realize the philosophical and cultural basis and historical perspectives of human rights.

Course Contents:

UNIT 1: The Basic Concepts: **[08 Hours]**

Individual, group, civil society, state, equality, justice. Human Values, Human rights and Human Duties: - Origin, Contribution of American bill of rights, French revolution. Declaration of independence, Rights of citizen, Rights of working and exploited people.

UNIT 2 Fundamental rights and economic programme: [07 Hours]

Society, religion, culture, and their inter relationship. Impact of social structure on human behavior, Social Structure and Social Problems: - Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labor.

UNIT 3: Migrant workers: [07 Hours]

Migrant workers and human rights violations, human rights of mentally and physically challenged. State, Individual liberty, Freedom and democracy. NGOs and human rights in India: - Land, Water, Forest issues.

UNIT 4: Human rights in Indian constitution and law [07 Hours]

i) The constitution of India: Preamble ii) Fundamental rights. iii) Directive principles of state policy. iv) Fundamental duties. v) Some other provisions.

UNIT 5: Universal declaration: [07 Hours]

Universal declaration of human rights and provisions of India. Constitution and law. National human rights commission and state human rights commission

Text / Reference Books

1. Shastry, T. S. N., India and Human rights: Reflections, Concept Publishing Company India (P Ltd.), 2005

2. Nirmal, C.J., Human Rights in India: Historical, Social and Political Perspectives(Law in India), Oxford India

Semester –IV

Probability Theory and Random Processes

BTBS404	**Probability Theory and Random Processes**	**BSC8**	**3L- 0T -0P**	**3 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

1. To develop basic of statistics, probability and random variables.
2. The primary objective of this course is to provide mathematical background and sufficient experience so that the student can read, write, and understand sentences in the language of probability theory, as well as solve probabilistic problems in engineering and applied science.

Course Outcomes:
On completion of the course, students will be able to:

CO1	Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon
CO2	Understand the basic concepts of one and two dimensional random variables and apply in engineering applications
CO3	Apply the concept random processes in engineering disciplines
CO4	Understand and apply the concept of correlation and spectral densities
CO5	The students will have an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable. Able to analyze the response of random inputs to linear time invariant systems

Course Contents:

UNIT 1: Probability Theory **[07 Hours]**

Definition of probability: classical, empirical and axiomatic approach of probability, Addition theorem of probability, Multiplication theorem of probability, Bayes‘ theorem of inverse probability, Properties of probabilities with proofs, Examples.

UNIT 2: Random Variable and Mathematical Expectation **[07 Hours]**

Random variables, Probability distributions, Probability mass function, Probability density function, Mathematical expectation, Join and marginal probability distributions, Properties of expectation and variance with proofs. Theoretical Probability Distributions : Binomial distribution, Poisson distribution, Normal distribution, Fitting of binomial distributions, Properties of binomial, Poisson and normal distributions, Relation between binomial and normal distributions, Relation between Poisson and normal distributions, Importance of normal distribution, Examples.

UNIT 3: Correlation **[07 Hours]**

Introduction, Types of correlation, Correlation and causation, Methods of studying correlation, Karl Pearson's correlation coefficient, Spearman‘s rank correlation, Coefficient, Properties of Karl Pearson's correlation coefficient and Spearman‘s rank correlation coefficient, Probable errors.

UNIT 4: Linear Regression Analysis **[07 Hours]**

Introduction, Linear and non-linear regression, Lines of regression, Derivation of regression lines of y on x and x on y, Angle between the regression lines, Coefficients of regression, Theorems on regression coefficient, Properties of regression coefficient.

UNIT 5: Estimation and Hypothesis **[07 Hours]**

Estimation, Large Sample Estimation of a Population Mean, Small Sample Estimation of a Population Mean, Large Sample Estimation of a Population Proportion, Sample Size Considerations, Testing Hypotheses, The Elements of Hypothesis Testing, Large Sample Tests for a Population Mean, The Observed Significance of a Test, Small Sample Tests for a Population Mean, Large Sample Tests for a Population Proportion.

Text Books

1. S. C. Gupta, Fundamentals of Statistics, Himalaya Publishing House, 7th Revied and Enlarged Edition, 2016.

Reference Books

1. 1. G. V. Kumbhojkar, Probability and Random Processes, C. Jamnadas and Co., 14th Edition, 2010.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi, 2010.
4. G. Haribaskaran, Probability, Queuing Theory and Reliability Engineering, Laxmi Publications,2nd Edition, 2009.
5. Murray Spiegel, John Schiller, R. ALU Srinivasan, Probability and Statistics, Schaum's Outlines,4th Edition, 2013.
6. Kishor S. Trivedi, Probability, Statistics with Reliability, Queuing and Computer ScienceApplications, Wiley India Pvt. Ltd, 2nd Edition, 2001.
7. Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh, An Introduction to Probability And Statistics, Wiley Publication, 2nd Edition, 2001.
8. Roxy Peck, Chris Olsen, Jay Devore, Introduction to Statistics and Data Analysis, Third Edition,Thomson Books/Cole.
9. Ronald Walpole; Raymond Myers; Sharon Myers; Keying Ye, Probability & statistics forengineers & scientists, 9th edition, Prentice Hall.

Semester –IV

Numerical Methods and Computer Programming

BTAIPE405A	**Numerical Methods and Computer Programming**	**PEC1**	**3L- 1T -0P**	**4 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

1. To prepare students for successful career in industries, for Post Graduate programmes and to work in research institutes.
2. To understand different numerical techniques used for solving algebraic and transcendental equations.
3. To understand numerical methods to solve a system of linear equations.
4. To understand numerical integration and differentiation techniques.
5. To understand various difference operators and interpolation techniques.
6. To understand object-oriented programming fundamentals and features.
7. To mold students professionally by course contents and sufficient problem solving and programming exercises and to acquaint them with different types of numerical techniques and programming concepts.

Course Outcomes:
On completion of the course, students will be able to:

CO1	Able to solve algebraic and transcendental equations by using numerical techniques and will be able to compare different numerical techniques used for this purpose and also will be able to choose a proper one as per the requirement of the problem
CO2	Able to solve a system of linear equations with any number of variables using different direct and iterative numerical techniques
CO3	Understand the concept of interpolation, finite difference operators and their relations, and can apply different interpolation techniques on equi-spaced or non equi-spaced data values
CO4	Prepare them to solve Integration and Differentiation
CO5	Understand application of the NMCP course in many engineering core subjects like signal processing, digital communication, numerical techniques in electromagnetics etc.

Course Contents:

UNIT 1: Introduction to Computational Methods and Errors: **[07 Hours]**

Computational Methods: General principles of computational techniques, Introduction, common ideas and concepts of computational methods, various computational techniques.

Errors: Types and sources of errors, Concept in error estimation, Error propagation, Error due to floating point, Representation of errors, Elementary uses of series in calculation of errors.

UNIT 2: Solution of Transcendental / Polynomial Equations and System of Linear Equation: [07 Hours]

Solution of Transcendental / Polynomial Equations: Finding root of polynomial equations deploying computational methods such as Bisection, Regula-falsi, Newton-Raphson, Seccant, Successive approximation. System of linear equation: Solving linear equations deploying computational methods such as Gauss elimination, Gauss Jordan, Partial pivoting, Matrix triangularisation (LU decomposition), Cholesky, Gauss Seidel and Jacobi methods.

UNIT 3: Interpolation and Polynomial Approximation: [07 Hours]

Least square approximation, Orthogonal polynomials Chebyshev polynomials, Finite difference operator and their relations, Forward, backward, central and divided difference, Newton's forward divided difference, Backward difference interpolation, Sterling interpolation, Lagrange sinterpolation polynomials, Spline interpolation, Least square approximation.

UNIT 4: Numerical Integration and Differentiation [07 Hours]

Numerical Integration: Methods based on interpolation such as Trapezoidal rule, Simsons 1/3 and 3/8 rules. Numerical differentiation: Euler's method, Modified Euler's method, Taylor's series, Runge Kutta 2ndand 4th order, Stability analysis of above methods.

UNIT 5: Object Oriented Programming: [07 Hours]

Software Evaluation, Object oriented programming paradigm, Basic concepts of object oriented programming, Benefits of OOP, Object oriented languages, Applications of OOP Beginning with C++: Structure of C++ program, Creating the source file, Compiling & linking, Basic data types, User defined data types, Symbolic constants, Declaration of variables, Dynamic initialization of variables, Reference variables, Operators in C++, Scope resolution operator, Type cast operator. Functions in C++: Function prototyping, Inline functions, Function overloading, Friend and virtual functions. Classes and Objects: Specifying a class, Defining member functions, C++ program with class, Arrays within a class, Memory allocation for objects, Constructors, Multiple constructor in class, Dynamic initialization of objects, Dynamic constructor, Destructors..

Note: OOPS hands-on should cover under Tutorial slots.

Text / Reference Books

1. S. S. Sastry, "Introductory Methods of Numerical Analysis", PHI, 1990, 3rdedition.
2. V. Rajaraman, "Computer Oriented Numerical Methods, PHI, New Delhi", 2000, 3rdEdition.
3. E. V. Krishnamurthy, and Sen S. K., "Numerical Algorithm: Computations in Science and Engg", Affiliated East West, New Delhi,1996.
4. D. Ravichandran, "Programming with C++",TMH
5. E. Balagurusamy, "Object-Oriented Programming with C++", TMH, New Delhi, 2001,2ndEdition
6. YeshwantKanetkar, "Let us C++, BPB Pub.", Delhi, 2002,4thEdition.
7. StroupstrupBjarne, "C++ Programming Language", Addison Wesley, 1997, 3rdEdition.
8. Horton, "Beginning C++: The Complete Language", Shroff Pub., Navi Mumbai,1998.

Semester –IV

Image Processing and Computer Vision

BTAIPE405B	Image Processing and Computer Vision	PEC1	3L-1T-0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Prerequisites: Digital Signal Processing

Course Objectives:

1. To let the students learn the fundamental principles on the aspects of interdisciplinary research including acquiring, processing, analyzing, understanding and utilizing high-dimensional visual data from the real world;
2. To equip the students with the knowledge of how to develop artificial intelligent systems which automate tasks that the human visual system can do;
3. To guide the students to understand the relevant state of art technologies and gain experience throughout a variety of case studies.

Course Outcomes:

On completion of the course, students will be able to:

CO1	To implement fundamental image processing techniques required for computer vision
CO2	Understand Image formation process
CO3	To perform morphological operations on image.
CO4	Extract features form Images and do analysis of Images
CO5	To develop applications using computer vision techniques

Course Contents:

Unit 1: Introduction to Digital Image Processing **[07 Hours]**

Motivation & Perspective, Applications, Types of images, image file formats, Fundamentals Steps in Image Processing, Components of Image Processing System, Image digitization, Some basic relationships, Distance Measures between pixels, Image basic operation, Special Operations.

Unit 2: Image Enhancement and Transformation **[08 Hours]**

Image Enhancement: Introduction, Methods, Basic Intensity Transformation: Image Negatives, Log transformation, Power law Transformation, piecewise linear transformation functions, Histogram processing, Histogram Equalization and Matching.

Basics of Spatial Filters, 2D Convolution & 2D Correlation, Smoothening (LPF) (Linear: Box, Gaussian & Non Linear: Median) and Sharpening (HPF): Laplacian operators, Unsharp Masking and Highboost Filtering, Combining Spatial Enhancement Methods.

Image Transforms: Discrete Fourier transform (DFT): Definition and properties, FFT, DCT.

Unit 3: Morphological operations [06 Hours]

Introduction, erosion, dilation, opening, closing, Hit or Miss, boundary extraction, hole filling, connected components, the convex hull, thinning, thickening, skeletonization, and pruning.

Unit 4: Segmentation and Feature Extraction [08 Hours]

Segmentation: Fundamentals; Point, Line and Edge Detection; Basics of edge detection: Image gradient and operators, Thresholding: Intensity Thresholding, Global thresholding, Segmentation by region growing, region splitting and merging.

Feature Extraction: Boundary Preprocessing: Boundary Following (Tracing), Chain Codes (freeman & slope), Polygonal approximation, Signature, Boundary description: Shape number, Fourier Descriptor, Statistical Moments, Region Feature Descriptors: Topological feature, Texture.

Unit 5: Pattern Recognition [07 Hours]

Pattern and pattern classes, pattern classification by prototype matching (Minimum-Distance Classifier & using correlation for 2-D prototype matching), matching by structural prototype. Introduction to Bayes statistical classifiers, Introduction to Neural Network and Deep Learning.

Note: Hands-on practice of Image Processing using openCV should cover under Tutorial slots.

Text Books:

1. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.
2. Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Publisher: Prentice Hall.
3. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc., 1992.
4. Dhananjay K. Theckedath, Image Processing using MATLAB codes, Nandu Printers and Publishers Pvt. Ltd, Third edition.

Reference Books:

1. D. H. Ballard, C. M. Brown. Computer Vision. Prentice-Hall, Englewood Cliffs, 1982.
2. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA). Springer, 2010
3. Image Processing, Analysis, and Machine Vision. Sonka, Hlavac, and Boyle. Thomson.
5. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012
6. Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Edition, Academic Press, 2012.

Semester –IV

Internet of Things & Embedded System

BTAIPE405C	Internet of Things & Embedded System	PEC1	3L-1T-0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Prerequisites: Basics if microprocessor, microcontroller, C language

Course Objectives:

1. To get the understanding of the concepts of Internet of Things
2. To enable the students to build IoT applications.
3. To understand the various protocols in IoT and Networking.
4. To develop the essential programming skill required

Course Outcomes:

On completion of the course, students will be able to:

CO1	The use of concepts of IoT and its areas.
CO2	Understand the basics of C and NodeMCU
CO3	Understand the basics of Python & Raspberry Pi
CO4	Interacting with Web Services and IoT protocol
CO5	Apply the IoT in various applications.

Course Contents:

Unit-1: Introduction to IoT [07 Hours]

Definition, characteristics of IoT, logical design of IoT, IoT communication models, IoT communication APIs: REST, Websocket, IoT Enabling Technologies: Wireless sensor networks, Cloud computing, Big data analytics, communication protocols, Embedded systems, IoT vs M2M.

Unit-2: Introduction to C and Node Mcu [07 Hours]

C: Introduction, Data types, variable, operator, branches, loops, functions, Debugging and Optimization of C programs.

NodeMCU: 8266 Wi-Fimodule, hardware and pin diagram, Interface with Arduino IDE. Interfacing of analog and digital sensors.

Unit-3: Introduction to Python and Raspberry Pi **[08 Hours]**

Python: Python IDE, Data types, variable, operator, branches, loops, functions, List, Dictionary, Writing to a File, Reading from a File, handling exceptions.

Raspberry Pi: Models of Raspberry pi, R Pi 3 hardware, GPIO pins, operating system for R pi3, Basic of Linux commands, configuring R pi3, Interfacing of Digital and Analog sensors.

Unit-4: **Interacting with Web Services** **[07 Hours]**

Configuring NodeMCU to connecting to server, NodeMCU interfacing with web services, configuring R pi 3 Wi-Fi and Ethernet, publishing and subscribing data from web using R pi3, interfacing R Pi 3 with twitter and whatsapp.

Unit-5: IoT Protocols **[07 Hours]**

UART, Wi-Fi, Ethernet, Bluetooth Low Energy (BLE), Message Queue Telemetry Transport (MQTT), Extensible Messaging and Presence Protocol (XMPP), Data Distribution Service (DDS), Advanced Message Queuing Protocol (AMQP).

Note: Hands-on practice of Internet of Things should cover under Tutorial slots.

Text Books:

1. Get Started With ESP8266 Programming NodeMCU Using Arduino, Up skill Learning.
2. Internet of Things with Raspberry Pi 3, ManeeshRao, pack
3. Internet of Things with ESP8266, Marco Schwartz
4. Internet of Things with Arduino Cookbook, Marco Schwartz

Reference Books:

1. Internet of Things: A Hands-On Approach- Arsheep Bahga,Vijay Madisetti
2. Raspberry Pi Cookbook for Python Programmers by Tim Cox
3. Learning Internet of Things, Peter Waher

Semester –IV

Programming in JAVA

BTAIPE405D	Programming in JAVA	PEC1	3L-1T-0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam:20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Basics of programming languages and Concepts of Object Oriented Programming languages.

Course Objectives:

After completion of the course, the students will be able to:
1. Apply object oriented features to real time entities.
2. Handle exceptions & implement multithreaded programs.
3. Implement database programming.
4. Design & implement GUI with event handling
5. Develop I/O & networking programs.

Course Outcomes:

On completion of the course, students will be able to:

CO1	To understand basics of JAVA
CO2	To use Packages & interfaces
CO3	To apply Exception Handling & Multithreaded Programming
CO4	To acquire Java Database Connectivity
CO5	To recognize Applet, Event Handling and AWT

Course Contents:

Unit 1: Introduction, Packages & interfaces [8 Hours]

Features of Java, Java Virtual Machine, Byte Code, JIT Compiler, Class fundamentals, Declaring objects, Nested and Inner Classes, Introducing Methods, Constructors, Garbage Collection, Overloading Methods, Using Objects as Parameters, Returning Objects, Access Control, Understanding static & final keyword, Inheritance Basics, Using Super, Method Overriding, Abstract Classes, Using final keyword with inheritance, Arrays, Vectors, Strings, Wrapper classes, Using Command-Line Arguments.

Packages: Defining a Package, Finding Packages and CLASSPATH, A Short Package Example, Access Protection, Importing Packages, Study of java.lang & java.util packages, Interfaces: Defining an Interface, Implementing Interfaces, Variables in Interfaces, Extending Interfaces, Multiple Inheritance.

Unit 2: Exception Handling & Multithreaded Programming [07 Hours]

Exception handling fundamentals, Exception Types, Using try-catch, Multiple try-catch clauses, Nested try statements, throw, throws, finally, Built-in Exceptions, creating your own exception subclasses, The Java Thread Model, The Main Thread, Creating a Thread , Creating Multiple Threads, Using isAlive( ) and join( ), Thread Priorities, synchronization, Suspending, Resuming, and Stopping Threads

Unit 3: Applet, Event Handling and AWT [07 Hours]

Applet: Applet Basics, An Applet Skeleton, Simple Applet Display Methods, Using the Status, Window, The HTML APPLET Tag, Passing Parameters to Applets, Event Handling: The Delegation Event Model, Event Classes, Sources of Events, Event, Listener Interfaces, Handling Mouse and Keyboard Events, Adapter Classes, Introduction to AWT , AWT classes, Window, Creating a Frame Window in an Applet, Working with Graphics.

Unit 4: Input /Output & Networking [07 Hours]

Input /Output: I/O Basics, Reading Console Input, Writing Console Output, The PrintWriter Class, Reading and Writing Files, The Stream Classes, The Byte Streams, The Character Streams, Object Serialization & deserialization, Networking: Networking Basics, The Networking Classes and Interfaces, TCP/IP Client, Sockets, TCP/IP Server Sockets, Datagrams

Unit 5: Java Database Connectivity [07 Hours]

Introduction, Types of JDBC Drivers, Driver interface & DriverManager class, Connection Interface, Statement Interface, PreparedStatement , ResultSet, JDBC Program for executing Statements & processing ResultSet, Using PreparedStatement.

Note: Hands-on practice of Programming in Java should cover under Tutorial slots.

Text / Reference Books:

1. Herbert Schildt, The Complete Reference- Java2, (Seventh Edition), Tata Mc Graw Hill.
2. Steven Holzner, Java 2 Black Book, Dream Tech Press.
3. Deitel & Deitel, Java: How to Program, PHI.
4. Bert Bates, Kathy Sierra, Head First Java, O'Reilly Media, Inc.
5. E Balagurusamy, Programming with Java, Tata Mc Graw Hill.

Semester –IV

Data Analysis Lab and Database Management System Lab

BTAIL406	**Data Analysis Lab and Database Management System Lab**	**LC2**	**0L-0T-4P**	**2 Credits**

Teaching Scheme	**Examination Scheme**
Practical: 04 hrs./week	Continuous Assessment 1: 30 Marks Continuous Assessment 2: 30 Marks End Semester Examination: 40 Marks

Data Analysis Lab

List of practicals:

1. Installing R and R Studio
2. Data types, mathematical operators and functions in R.
3. Vectors, Factors, Lists, Matrix, Data Frames in R.
4. Measurement of Central Tendency Mean, Median and Mode.
5. Measurement of Variation - Range, IQR and Standard Deviation.
6. Descriptive Statistics Using psych Package.
7. One & two Sample z Test Using R
8. One & two Sample t Test Using R
9. Goodness of Fit Test Using R
10. Contingency Table Using R
11. Analysis of Variance (ANOVA) Using R
12. Central Limit Theorem Demonstration Using R
13. R Functions for Normal Distribution - rnorm, pnorm, qnorm and dnorm
14. R Functions for Binomial Distribution - rbinom, pbinom, qbinom and dbinom
15. R Functions for Poisson Distribution - rpois, ppois, qpois and dpois

Database Management System Lab

List of practical:

1. Draw E-R diagram and convert entities and relationships to relation table for a college database.
2. Perform the following:
   a) Viewing all databases,
   b) Creating a Database,
   c) Viewing all Tables in a Database,
   d) Creating Tables (With and Without Constraints),
   e) Inserting/Updating/Deleting Records in a Table,
3. Perform the following:
   a) Altering a Table,
   b) Dropping/Truncating/Renaming Tables,
   c) Backing up / restoring a Database.
4. For a given set of relation schemes, create tables and perform the following-
   a) Simple Queries,
   b) Simple Queries with Aggregate functions,
   c) Queries with Aggregate functions (group by and having clause),
5. Perform queries with Date functions and String Functions
6. Perform queries with Math Functions, Join Queries- Inner Join, Outer Join and Subqueries- With IN clause, With EXISTS clause
7. Implement a columnar database using Apache Cassandra
8. Implement a document database with MongoDB
9. Design and Implement any 5 query using MongoDB
10. Write a case study for various types of NoSQL databases.

Note:

1. Lab should be in scope of hands of experience and practice related program must
2. Add case study and Live project experience if any related contents

Semester –IV
Seminar-II

BTAIS407	**SEMINAR-II**	**Seminar**	**0L-0T-4P**	**2 Credits**

Guidelines for Seminar

The students shall study in group of two members (or individual) on some special topic beyond the scope of the syllabus under the subjects of Artificial Intelligence, Data Science, Electronics Engineering and Computer Science Engineering or inter discipline branch from current literature, by referring the current technical journal or reference books, under the guidance of the teacher. The students shall prepare his report and deliver talk on the topic for other students of his class in the presence of his guide and internal examiner. The student is permitted to use audio-visual aids or any other such teaching aids.

Continues Assessment:

The Continues Assessment for this head will consists of the report written in a technical reporting manner and presentation of the talk on the subject and will be assessed by the internal examiner appointed by the HOD of concern department of the institution.

Semester –IV
Internship - II

BTAIP408	**Field Training / Internship / Industrial Training**	**Internship**	**Audit**

Guidelines for Internships

Guidelines for Field Training / Internship / Industrial Training Industrial Training:

1. To apply for a suitable Industrial Training, submit an application form to respective Organization concerned one semester before the Industrial Training Programmed commences.
2. Student can also apply through online platforms such as Internshala for industrial training.
3. Submit one copy of the offer letter for the Industrial Training to the Head of the department or Faculty coordinator (Industrial Training).
4. To complete the Industrial Training process within the specified time based on the Industrial Training Programme schedule.
5. Assessment within the Industrial Training context aims to evaluate the student's work quality and appropriateness to the field of study with reference to the learning outcomes of the Industrial Training Programme.
6. Evaluation of the students' performance should be done in the next upcoming semester.
7. Those students who fails, they can also complete online certification courses which are available at free of cost on various MOOC platforms.

COURSE CURRICULUM MAPPING WITH MOOC PLATFORM NPTEL

Sr. No	Name of Subject as per Curriculum	Course Code	Semester	SWAYAM/ NPTEL Course And Web Link	Name of Institute offering course	Relevance %	Duration of Course
1	Engineering Mathematics -III	BTBS301	III	Linear Algebra https://nptel.ac.in/courses/111/ 106/111106051/	IIT, Madras	90%	12 weeks
2	An Introduction to Artificial Intelligence	BTAIC302	III	Artificial Intelligence : Search Methods For Problem solving	IIT Madras	90%	12 weeks
				An Introduction to Artificial Intelligence	IIT Delhi	90%	12 weeks
3	Data Structure and Algorithm using Python	BTAIC303	III	Programming, Data Structures And Algorithms Using Python https://onlinecourses.nptel.ac.in/noc21_cs67/preview	Chennai Mathematical Institute	90%	8 week
4	Computer Architecture & Operating System	BTAIC304	III	Computer architecture and organization https://onlinecourses.nptel.ac.in/noc21_cs61/preview	IIT KHARAGPUR	100 %	12Weeks
5	Digital Logic & Signal Processing	BTESC305	III	Principles Of Signals And Systems https://nptel.ac.in/courses/108/104/108104100/	IIT KANPUR	60%	12Weeks
				Digital Signal Processing https://nptel.ac.in/courses/117/102/117102060/	IIT Delhi	60%	12Weeks
6	Data Analysis	BTAI401	IV	Data Science for Engineers https://onlinecourses.nptel.ac.in/noc21_cs69/preview	IIT Madras	60%	8 week
7	Database Management System	BTAI402	IV	Database Management System https://onlinecourses.nptel.ac.in/noc19_cs46/preview	IIT Kharagpur	50%	8 week
8	Basic Human Rights	BTHM403	IV	https://nptel.ac.in/courses/109/104/109104068/	IIT KANPUR	50%	8 week
9	Probability Theory and Random Processes	BTBS404	IV	Introduction to Probability Theory and Stochastic Processes https://onlinecourses.nptel.ac.in/noc21_ma66/preview	IIT Delhi	90%	12 weeks
10	Numerical Methods and Computer Programming	BTSE405A	IV	Numerical methods and programing https://nptel.ac.in/courses/122/106/122106033/	IIT Madras	70%	12 week
11	Image Processing & Computer Vision	BTSE405B	IV	Computer Vision and Image Processing - Fundamentals and Applications https://onlinecourses.nptel.ac.in/noc21_ee23/preview	IIT Guwahati	80%	12 week
12	Internet of Things & Embedded System	BTSE405C	IV	Introduction To Internet Of Things https://nptel.ac.in/courses/106/105/106105166/	IIT Kharagpur	70%	12 Weeks
				Design for Internet of things https://nptel.ac.in/courses/108/108/108108098/	IISc Banglore	40%	8Weeks
13	Programming In Java		IV	https://onlinecourses.nptel.ac.in/noc19_cs84/preview	IIT Kharagpur	100 %	12 Weeks

COURSE CURRICULUM MAPPING WITH MOOC PLATFORM COURSERA

Sr. No	Name of Subject as per Curriculum	Course Code	Semester	Coursera Course And Web Link	Name of Institute offering course	Relevance %	Duration of Course
1	Engineering Mathematics- III	BTBS301	III	Mathematics for Machine Learning: Linear Algebra	Imperial College Landon	25%	5 week
2	An Introduction to Artificial Intelligence	BTAIC302	III	AI For Everyone	DeepLearning.AI	50%	4 week
3	Programming, Data Structure and Algorithm using Python	BTAIC303	III	Python Data Structures https://www.coursera.org/learn/python-data	University of Michigan	70%	7 weeks
4	Computer Architecture& Operating System	BTAIC304	III	Computer Architecture	Princeton University, US	25	4 Weeks
6	Data Analysis	BTAI401	IV	Statistics with R Specialization	Duke University	50%	5 Weeks
7	Database Management System	BTAI402	IV	Database Management Essentials https://www.coursera.org/learn/database-management	University of Colorado	40%	4 weeks
9	Probability Theory and Random Processes	BTBS404	IV	Probability Theory, Statistics and Exploratory Data Analysis	National Research University Higher School of Economics	80	6 Weeks
11	Image Processing & Computer Vision	BTSE405B	IV	1) Fundamentals of Digital Image and Video Processing 2)Computer Vision Basics	1) Northwestern University 2) University at Buffalo The State University of New York	1)25 2)25	1)4 Weeks 2)4 Weeks
12	Internet of Things & Embedded System	BTSE405C	IV	Hands-on Internet of Things Specialization(4 courses included in it)	University of Illinois at Urbana-Champaign	70	4 week per course
13	Programming in JAVA	BTSE405D	IV	Core Java Specialization https://www.coursera.org/specializations/core-java#courses	Learn Quest	70%	6 week

COURSE CURRICULUM MAPPING WITH MOOC PLATFORM Edx

Sr. No	Name of Subject as per Curriculum	Course Code	Semester	Edx Course And Web Link	Name of Institute offering course	Relevance %	Duration of Course
1	An Introduction to Artificial Intelligence	BTAIC302	III	Artificial Intelligence (AI)	Colambia University	80%	12 Week
2	Data Structure and Algorithm using Python	BTAIC303	III	1) Foundations of Data Structures	1) IIT Bombay	1) 70%	1) 6 Weeks
				2) Algorithms and Data Structures	2) UCSan Diego	2) 60%	2) 4 Weeks
3	Computer Architecture& Operating System	BTAIC304	III	1. Computer Organization	1. MITx	1. 20%	10 Weeks
				2. Computer Architecture	2. MITx	2. 20%	
4	Data Analysis	BTAI401	IV	StaStatistics and Data	MITx	60%	1 Year
5	Database Management System	BTAI402	IV	Databases: SQL	Stanford Online	50	8 Weeks
6	Probability Theory and Random Processes	BTBS404	IV	Introduction to Probability	Harvard University	50	8 Weeks
7	Image Processing & Computer Vision			Image Processing and Analysis for Life Scientists	EPFLx	50	7 Weeks
8	Internet of Things & Embedded System	BTSE405B	IV	Design for Internet of things https://nptel.ac.in/courses/108/108/108108098/	IISc Banglore	40	8Weeks
				IoT: from hardware to practice	ITMOx University	40	17 Weeks
9	Programming in JAVA	BTSE405D	IV	Introduction to Object-Oriented Programming with Java II: Object-Oriented Programming and Algorithms https://www.edx.org/course/introduction-to-java-programming-ii-object-oriented-programming	Georgia Institute of Technology	100 %	6 week
	Programming in JAVA	BTSE405D	IV	Introduction to Object-Oriented Programming with Java III: Exceptions, Data Structures, Recursion, and GUIs https://www.edx.org/course/introduction-to-java-programming-iii-interfaces-polymorphism-and-complexity			6 week
	Programming in JAVA	BTSE405D	IV	Introduction to Object-Oriented Programming with Java I: Foundations and Syntax Basics https://www.edx.org/course/introduction-to-java-programming-i-foundations-and-syntax-basics			6 week

Semester –V

Computer Network and Cloud Computing

BTAIC501	Computer Network and Cloud Computing	PCC5	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Computer Fundamentals, Fundamentals of Digital Communication

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Theoretical and practical base in computer networks issues
2. Outline the basic network configurations
3. Understand state-of-the-art in network protocols, architectures, and applications
1. Fundamental concepts of cloud computing
2. Implementation of virtualization and various cloud services

Course Outcomes:

On completion of the course, students will be able to:

CO1	Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies
CO2	Specify and identify deficiencies in existing protocols, and then go onto select new and better protocols.
CO3	Have a basic knowledge of installing and configuring networking applications
CO4	Understand the different cloud computing environments
CO5	Apply concepts of virtualization and various cloud services to design, develop and deploying cloud applications.

Course Contents:

Unit No 1: Introduction to Computer Networks [7 Hours]

Uses of computer networks, Types of computer networks, Network technology- from local to global, Examples of networks, Network protocols, Reference models, Standardization, policy, legal, and social issues.

Unit No 2: The Data Link Layer and Network Layer [8 Hours]

Data link layer design issues, Error detection and correction, Elementary data link protocols, The channel allocation problem, Multiple access protocols, Network layer design issues, Routing algorithms in a single network, Traffic management at the network layer,

internetworking, software-defined networking, The network layer in the internet.

Unit No 3: Transport and Application Layers [7 Hours]

The transport service, Elements of transport protocols, The internet transport protocols: UDP and TCP, The Domain Name System (DNS), Electronic mail, The world wide web, Streaming audio and video, Content delivery.

Unit No 4: Introduction to Cloud Computing [7 Hours]

Definition and evolution of Cloud Computing, Enabling Technologies, Service and Deployment Models, Popular Cloud Stacks and Use Cases, Benefits, Risks, and Challenges of Cloud Computing, Economic Models and SLAs, Topics in Cloud Security. Historical Perspective of Data Centers, Data center Components.

Unit No 5: Virtualization and Cloud Services [7 Hours]

Communication-as-a-Service (CaaS), Infrastructure-as-a-Service (IaaS), Monitoring-as-a-Service (MaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS). Virtualization (CPU, Memory, I/O) Case Study: Amazon EC2.

Note: Hands-on practice of Computer Network and any cloud services (like Amazon WebServices (AWS Cloud) or Microsoft Azure or Google Cloud) should cover under Tutorialslots.

Text Books

1. A Tanenbaum, N Feamster, D Wetherall, Computer Networks, Sixth Edition, Pearson Education Limited. ISBN 10: 1-292-37406-3, 2021
2. John W. Rittinghouse, James F. Ransome, Cloud Computing Implementation, Management, and Security, CRC Press , Routledge Publisher, ISBN-10 : **1818 ,1189978311879**

Reference Books

1. B. Forouzan, Data Communications and Networking, McGraw Hill Publication, 5th Edition, 2013.
2. Larry Peterson and Bruce Davie, Computer Networks: A Systems Approach, Morgan Kufman
3. Publication, 5th Edition, 2012.Ronald L. Krutz, Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Wiley-India, 2010.
4. Anthony T. Velte, Toby J. Velte and Robert E, Cloud Computing – A Practical Approach, TMH, 2010

Semester –V

Machine Learning

BTAIC502	Machine Learning	PCC6	3L- 0T - 0P	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Data Analysis, Python Programming Language

Course Objectives:

After completion of the course, students will learn:-

- To understand fundamental concepts of machine learning and its various algorithms
- To understand various strategies of generating models from data and evaluating them
- To apply ML algorithms on given data and interpret the results obtained
- To design appropriate ML solution to solve real world problems in AI domain

Course Outcomes:

On completion of the course, students will be able to:

CO1	Develop a good understanding of fundamental principles of machine learning
CO2	Formulation of a Machine Learning problem
CO3	Develop a model using supervised/unsupervised machine learning algorithms for classification/prediction/clustering
CO4	Evaluate performance of various machine learning algorithms on various data sets of a domain.
CO5	Design and Concrete implementations of various machine learning algorithms to solve a given problem using languages such as Python

Course Contents:

Unit No 1: Introduction to Machine Learning [7 Hours]

Introduction to Machine Learning: Definition of Machine Learning, Definition of learning. Classification of Machine Learning: Supervised learning, unsupervised learning, Reinforcement learning, Semi-supervised learning.

Categorizing based on required Output: Classification, Regression, and Clustering. Difference in ML and Traditional Programming, Definition of Data, Information and Knowledge.

Split data in Machine Learning: Training Data, Validation Data and Testing Data.

Machine Learning: Applications

Unit No 2: Machine Learning - Performance Metrics [7 Hours]

Performance Metrics for Classification Problems- Confusion Matrix, Classification Accuracy, Classification Report- Precision, Recall or Sensitivity, Support, F1 Score, AUC (Area Under ROC curve).

Performance Metrics for Regression Problems- Mean Absolute Error (MAE), Mean Square Error (MSE), R Squared (R2)

Unit No 3: Linear and Logistic Regression [8 Hours]

Introduction to linear regression:

Introduction to Linear Regression, Optimal Coefficients, Cost function, Coefficient of Determination, Analysis of Linear Regression using dummy Data, Linear Regression Intuition.

Multivariable regression and gradient descent:

Generic Gradient Descent, Learning Rate, Complexity Analysis of Normal Equation Linear

Regression, How to find More Complex Boundaries, Variations of Gradient Descent.
Logistic regression:
Handling Classification Problems, Logistic Regression, Cost Function, Finding Optimal Values, Solving Derivatives, Multiclass Logistic Regression, Finding Complex Boundaries and Regularization, Using Logistic Regression from Sklearn.

Unit No 4: Decision Trees and Random Forests *[7 Hours]*

Decision trees:
Decision Trees, Decision Trees for Interview call, Building Decision Trees, Getting to Best Decision Tree, Deciding Feature to Split on, Continuous Valued Features
Code using Sklearn decision tree, information gain, Gain Ratio, Gini Index, Decision Trees & Overfitting, Pruning.
Random forests:
Introduction to Random Forests, Data Bagging and Feature Selection, Extra Trees, Regression using decision Trees and Random Forest, Random Forest in Sklearn

Unit No 5: Naive Bayes, KNN and SVM *[7 Hours]*

Naive Bayes:
Bayes Theorem, Independence Assumption in Naive Bayes, Probability estimation for Discrete Values Features, How to handle zero probabilities, Implementation of Naive Bayes, Finding the probability for continuous valued features, Text Classification using Naive Bayes.
K-Nearest Neighbours:
Introduction to KNN, Feature scaling before KNN, KNN in Sklearn, Cross Validation, Finding Optimal K, Implement KNN, Curse of Dimensionality, Handling Categorical Data, Pros & Cons of KNN.
Support Vector Machine:
Intuition behind SVM, SVM Cost Function, Decision Boundary & the C parameter, using SVM from Sklearn, Finding Non Linear Decision Boundary, Choosing Landmark Points, Similarity Functions, How to move to new dimensions, Multi-class Classification, Using Sklearn SVM on Iris, Choosing Parameters using Grid Search, Using Support Vectors to Regression.

Text Books

1. Ethem Alpaydın, Introduction to Machine Learning, PHI, Third Edition, ISBN No. 978-81-203-5078-6
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Mcgraw-Hill, ISBN No. 0- 07-115467-1
3. Tom Mitchell, Machine Learning, Mcgraw-Hill, First Edition, ISBN No. 0-07-115467-1.
4. Giuseppe Bonaccorso, "Machine Learning Algorithms", Packt Publishing Limited, ISBN10: 1785889621, ISBN-13: 978-1785889622

Reference Books

1. R.O. Duda, P.E. Hart, D.G. Stork, Pattern Classification, 2/e, Wiley, 2001
2. Shai shalev-Shwartz and Shai Ben-David, Understanding Machine Learning (From Theory to Algorithms), Cambridge University Press, First Edition, ISBN No. 978-1-107-51282-5.
3. A. Rostamizadeh, A. Talwalkar, M. Mohri, Foundations of Machine Learning, MIT Press.
4. A. Webb, Statistical Pattern Recognition, 3/e, Wiley, 2011.
5. https://python-course.eu/machine-learning/

Semester –V

Economics and Management

BTAIHM503A	Economics and Management	HSSMEC4	3L- 0T - 0P	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will learn to manage Economical things.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Study of Market Equilibrium
CO2	Understand Relevant Information and Decision Making
CO3	Aware Financial Statements
CO4	Study of Depreciation Accounting
CO5	Understand Product Development

Course Contents:

Unit No 1: Introduction: [7 Hours]

Market Equilibrium: Demand and Supply, Elasticity of Demand Forecasting, Production, Exercises on Economics, Cost-Volume-Profit Relationships, Cost Management Systems and Activity Costing System.

Unit No 2: Relevant Information and Decision Making [8 Hours]

Cost Allocation, Exercises on Economics, Double-Entry Bookkeeping, Job Casting, Process Costing, The Master Budget, Flexible Budgets and Variance Analysis.

Unit No 3: Financial Statements [7 Hours]

Analysis of Financial Statements, Time Value of Money, Comparison of Alternatives.

Unit No 4: Depreciation Accounting [7 Hours]

Evolution of Management Thoughts, Functions of Management Directing.

Unit No 5: Product Development [7 Hours]

Forecasting Revisited, Capacity Planning, Product / Services Strategies and Plant Layout, Production Planning and Control.

Text Books

1. R. Paneerselvam, Engineering Economics, PHI publication.

Reference Books

1. Robbins S.P. and Decenzo David A., Fundamentals of Management: Essential Concepts and Applications, Pearson Education.
2. L. M. Prasad, Principles and Practices of Management.

3. K. K. Dewett & M. H. Navalur, Modern Economic Theory, S. Chand Publications.

Semester –V

Business Communication

BTAIHM503B	Business Communication	HSSMEC4	3L- 0T - 0P	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will learn business Communication

Course Outcomes:

On completion of the course, students will be able to:

CO1	Study of business
CO2	Understand Intercultural Communication
CO3	Aware Barriers to Communication
CO4	Study of Interpersonal Communication
CO5	Understand Negotiation and Conflict Management

Course Contents:

Unit No 1: Introduction: [7 Hours]

Introduction, Definitions & Concepts, Communicative Competence.

Unit No 2: Intercultural Communication [8 Hours]

Intercultural Communication, Nonverbal Communication, Thought and Speech, Translation as ProblematicDiscourse.

Unit No 3: Barriers to Communication [7 Hours]

Barriers to Communication, Listening, Communication Rules, Communication Style.

Unit No 4: Interpersonal Communication [7 Hours]

Interpersonal Communication, Relational Communication, Organizational Communication. Collaboration,Communication in Groups and Teams, Persuasive Communication.

Unit No 5: Negotiation and Conflict Management [7 Hours]

Negotiation and Conflict Management, Leadership, Written Communication in International Business, Role of Technology in international Business Communication, Moving to Another Culture, Crisis Communication,Ethics in Business Communication.

Text Books

1. Mary Ellen Guffey, Essentials of Business Communication, Sixth Edition, South-Western College Publishing.

Reference Books

1. Bovee, Courtland, John Thill & Mukesh Chaturvedi, Business Communication Today: Dorling kindersley, Delhi.

2. Kaul, Asha, Business Communication, Prentice-Hall of India, Delhi.

3. Monippally, Matthukutty M. Business Communication Strategies. Tata McGraw-Hill Publishing Company Ltd., New Delhi.

4. Sharma, Sangeeta and Binod Mishra, Communication Skills for Engineers and Scientists, PHI Learning Pvt.

Ltd., New Delhi.

Semester –V

Knowledge reasoning and AI ethics

BTAIHM503C	**Knowledge reasoning and AI ethics**	**HSSMC4**	**3L- 0T - 0P**	**3 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. To provide a strong foundation of fundamental basics of knowledge reasoning & AI Ethics
2. Demonstrate awareness and fundamental understanding of knowledge reasoning
3. To impart knowledge about AI ethics.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Apply the knowledge and reasoning based concepts
CO2	Specify and identify the logical agents.
CO3	Apply Probabilistic Reasoning & Uncertainty along with rules.
CO4	Understand the human psychology and social ethics to use AI
CO5	Apply concepts of virtualization and various cloud services to design, develop and deploying cloud applications.

Unit 1: Knowledge & Reasoning **[7 Hours]**

Knowledge representation issues, Representation & mapping, Approaches to knowledge representation, semantic nets- frames and inheritance, Knowledge-Based Agents, The Wumpus World, Logic, Propositional Logic: A Very Simple Logic, Propositional Theorem Proving, Effective Propositional Model Checking, Agents Based on Propositional Logic

Unit 2: Logical Agents **[7 Hours]**

Using predicate logic: Representing simple fact in logic, Representing instant & ISA relationship, Computable functions & predicates, Resolution, Natural deduction. Representing knowledge using rules: Procedural versus declarative knowledge, Logic programming, forward versus backward reasoning, Matching, Control knowledge.

First-order logic: Representation Revisited Syntax and Semantics of First-Order Logic, Knowledge Engineering in First-Order Logic Inference in first-order logic, propositional vs. first-order inference, unification & lifts forward chaining, Backward chaining, Resolution

Unit 3: Probabilistic Reasoning & Uncertainty [7 Hours]

Quantifying Uncertainty, Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Independence, Bayes' Rule, and Its Use, The Wumpus World Revisited, Probabilistic Reasoning, Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks, Relational and First-Order Probability Models, and Other Approaches to Uncertain Reasoning.

Unit 4: Introduction to AI Ethics [7 Hours]

Artificial intelligence, ways of implementing AI, Advantages and disadvantages of AI, Definition of morality and ethics, Descriptive Ethics, Normative Ethics, Meta-ethics, Applied Ethics, Impact on society, Impact on human psychology, Impact on the legal system, impact on Environment and planet, impact on trust (privacy issues), challenges of AI and data governance, Ethical implications and responsibilities.

Unit 5: Ethical initiatives in the field of artificial intelligence [7 Hours]

International ethical initiatives, Autonomous systems, Ethical harms, Machine Ethics, Artificial moral agents Singularity, AI standard and regulation, IEEE 'human standards' with implications for AI, Ethics in military use of AI: use of weapons, regulations governing an AWS, Ethical Arguments for and Against AI for Military Purposes.

Text / Reference Book:

1. Knowledge Representation and Reasoning, by Hector Levesque and Ronald J. Brachman
2. Foundations of Knowledge Representation and Reasoning by Gerhard Lakemeyer, Bernhard Nebel
3. AI Ethics by Mark Coeckelbergh
4. An Introduction to Ethics in Robotics and AI by Christoph Bartneck, Christoph Lütge, Alan Wagner, Sean Welsh

Semester –V

Advanced Database Systems

BTAIPE504A	Advanced Database Systems	PEC2	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Nil.

Course Objectives:

Upon completion of this course, the student should be able to study database management systems.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Summarize the basic concept of Data base System.
CO2	Understand relational database models.
CO3	Demonstrate working of advanced SQL.
CO4	Understand data warehousing and mining concepts.
CO5	Understand the advanced transaction processing.

Course Contents:

Unit 1: Introduction to Database System and E-R Models **[8 Hours]**

Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases, Database Design, Data Storage and Querying, Transaction Management, Database Architecture Data modeling using the Entity Relationship Model: ER model concepts, notation for ER diagram, Constraints, keys, E-R Diagrams, Mapping Cardinality, Concepts of Super Key, candidate key, primary key, weak entity sets, Codd‘s rules, Extended ER model, Generalization, Aggregation, , Reduction of an ER diagrams to tables.

Unit 2: Relational Data Model, Relational Algebra and SQL **[7 hours]**

Structure of Relational Databases, Database Schema, Keys Relational algebra: Fundamental Operations, Additional Relational Algebra Operations, Extended Relational Algebra Operations. SQL: Overview of SQL, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operators, Set Operations, Null Values, Aggregate Functions, Nested Sub queries, Modification of the Database Intermediate SQL: Join Expressions, Views, Transactions, Integrity Constraints, SQL Data Types and Schema, Authorization.

Unit 3: Advanced SQL, Relational Database Design and Data Normalization **[7 hours]**

Advanced SQL: Assessing SQL from Programming Language, JDBC, ODBC, Embedded SQL, Functions and Procedures, Triggers, Normalization: Features of good relational designs, Functional dependencies, Normal forms, First, Second, Third normal forms, BCNF, Functional Dependency Theory, Multivalued Dependencies, Fourth Normal Form, Database Design Process.

Unit 4: Data Warehousing, Data Mining, and Information Retrieval [7 hours]

Database-System Architectures: Centralized and Client –Server Architectures, Parallel Systems, Distributed Systems. Data warehousing: Decision-Support Systems, Data Warehousing, Data Mining, Classification and Clustering, Association Rules, Other Forms of Data Mining and information retrieval.

Unit 5: Advanced Transaction Processing and Concurrency Control [7 hours]

Transaction Model Concepts, A Simple Transaction Model, Serializability Concurrency Control Techniques: Lock based Protocols, Deadlock handling, Multiple Granularity, Time stamp-Based Protocols.

Note: Hands-on practice should cover under Tutorial slots.Text Books

1. Henry Korth, Abraham Silberschatz & S. Sudarshan, Database System Concepts, McGraw- Hill Publication, 6th Edition, 2011.

Reference Books

1. Raghu Ramakrishnan, Johannes Gehrke, Database Management S ystems, McGraw- HillPublication, 3rd Edition, 2003.
2. Joel Murach, Murach's Oracle SQL and PL/SQL for Developers, Mike Murach & Associates, 2nd Edition, 2014.
3. Wiederhold, Database Design, McGraw-Hill Publication, 2nd Edition, 1983.
4. Navathe, Fundamentals of Database System, Addison-Wesley Publication, 6th Edition, 2012.
5. Mark L. Gillenson, Fundamentals of Database Management System, Wiley Publication, 2ndEdition, 2011.
6. Serge Abiteboul, Richard Hull, Victor Vianu, ―Foundations of Databases‖, Reprint by Addison-Wesley.
7. Jiawei Han, Micheline Kamber, and Jian Pei, ― Data Mining: Concepts and techniques by Morgan Kaufmann Publishers (an imprint of Elsevier)

Semester –V

Soft Computing

BTAIPE504B	Soft Computing	PEC2	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Basic Knowledge of Data Structures, Python.

Course Objectives:

Upon completion of this course, the student should be able to:

1. Differentiate between soft computing and hard computing.
2. Understand Neural Networks, its architecture, functions and various algorithms involved.
3. Understand Fuzzy Logic and Genetic algorithms.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Summarize the basic concept of soft computing and Neural network.
CO2	Choose appropriate activation and loss functions for neural network.
CO3	Demonstrate working of Feedforward and Backpropagation learning propagation.
CO4	Implement simple neural network in python.
CO5	Understand the need of fuzzy logic and genetic algorithm.

Course Contents:

Unit 1: Introduction of soft computing and Artificial Neural Networks [7 Hours]

soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing, Introduction to Neural Network, Biological Neural Network, Introduction to neuron, A simple neural network model,, training/Learning procedure of neural network, anatomy of neural network: neurons, layers, weights, bias, threshold, learning constants, learning rate, loss function, optimizer, dot product computation , McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm

Unit 2: Activation Functions, Loss Functions and optimizers [7 hours]

Need of activation Functions, Linear and non-linear activation function: Linear, RELU, sigmoid, tanh, softmax etc. Loss functions: squared error, Binary cross entropy, categorical/multiclass cross entropy. Optimizers: Derivatives, Gradient decent, stochastic gradient descent, Mini batch gradient descent.

Unit 3: Feedforward and Backpropagation learning [7 hours]

Learning propagation: forward propagation and backword propagation, Multilayer Perceptron's (MLPs), Representation Power of MLPs, Sigmoid Neurons, Feedforward Neural Networks: Feedforward Neural Networks, Backpropagation

Unit 4: Introduction to Artificial Neural Networks with python [7 hours]

Introduction to pytorch, tensorflow and keras. Data representation for Artificial neural network: scalars, vectors, matrices, high dimensional arrays (tensors), preparing the dataset, building simple neural network, feeding data to neural network, training neural network validating network, using trained network to generate prediction on new data, working example of feedforward and backpropagation neural network, Parameters and Hyper Parameters, overfitting and underfitting, dealing with overfitting in neural networks.

Unit 5: Introduction to Fuzzy logic and Genetic Algorithms [8 hours]

Fuzzy Logic: Classical sets, Fuzzy sets, fuzzy relations, Fuzzy propositions, Fuzzy implications, Fuzzy inferences, fuzzification and Defuzzification, fuzzy controllers, Applications.

Genetic Algorithms: basic concepts, working principle, Applications of GA.

Note: Hands-on practice of Soft Computing Algorithms should cover under Tutorialslots.

Text Books

2. Michael Nielsen, Neural Networks and Deep Learning, 2016
3. S. N. Sivanandam & S. N. Deepa, "Principles of Soft Computing", Wiley Publications.
4. B. Yegnanarayana, "Artificial Neural Networks", PHI Publications.
5. Deep Learning, An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville http://www.deeplearningbook.org.

Reference Books

1. Francois Challot, "Deep Learning with Python",second edition.
2. B. Satish Kumar, "Neural Networks - A Classroom Approach", McGrawHill Publication

S. Rajasekaran, VijaylakshmiPai, "Neural Networks, Fuzzy Logic and Genetic algorithmsSynthesis and Applications", PHI Publications.

Semester –V

Sensors and Robotics Technology

BTAIPE504C	**Sensors and Robotics Technology**	**PEC2**	**3L- 1T - 0P**	**4 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Digital Electronics, Microcontrollers, Microprocessors, Computer Algorithms.

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Concepts of measurement technology.
2. Various sensors used in measuring various physical parameters.
3. Fundamentals of signal conditioning, data acquisition and communication systems used in Robotics system development
4. Mathematics manipulations of spatial coordinate representation and transformation. Able to solve basic robot forward and inverse kinematic problems
5. Design essentials of robots and End Effectors

Course Outcomes:

On completion of the course, students will be able to:

CO1	**Classify** various robot essential transducers and **explain** their working principles with examples.
CO2	**Predict** the expected performance of various sensors
CO3	**Familiar** with the history, concept development and key components of robotics technologies.
CO4	**Implement** basic mathematics manipulations of spatial coordinate representation and transformation.
CO5	**Calculate** Gripping Force required for object manipulation by various robotic end effectors

Course Contents:

Unit No 1: Measurement and Sensors: [8 Hours]

Basics of Measurement, Classification of errors, Error analysis, Static and dynamic characteristics of transducers, Performance measures of sensors, Classification of sensors Sensor calibration techniques

Temperature: RTD, Thermocouple, Thermistor, Infrared, and LM35.

Humidity Sensors: Capacitive, Resistive, Thermal conductivity, and DHT11 Sensors.

Proximity sensors: Inductive, Capacitive, Magnetic, and optical proximity sensors.

Force and Pressure Sensors: Strain Gauge, Piezoelectric

Motion: Rotary and Linear motions, Gyroscope, Accelerometer, Magnetometer, MEMS

Chemical and Bio Sensors: Gas sensors, Nano Sensors

Vision Sensing: Digital Camera

Unit No 2: Data Acquisition and Actuators [7 Hours]

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

Introduction to Actuators , Classification, **Linear Actuators:** Electrical- Relays, Pneumatic/ Hydraulic- Single and Double Acting Cylinders, **Rotary Actuators:** Electrical- AC and DC Motors, Stepper Motors, Servo Motors, Pneumatic/Hydraulic Motors.

Pneumatic/Hydraulic Control Valves: 3/2 Valves, 5/3 Valves etc.

Unit No 3: Introduction to Robotic [7 Hours]

Definition; History of Robotics, Laws of Robotics, anatomy of robot: Motion subsystem, Recognition subsystem, and Control subsystem. Robot Specifications: Number of Axes, Load Carrying Capacity, Reach, Stroke, Repeatability, Precision, Accuracy, etc. . Classification of robot based on Drive Technologies, Work Envelop Geometry and Motion Control Methods. Safety Measures in robotics. Block Diagram representation of various Industrial Applications of Robots viz. Medical, Mining, Space, Underwater, Defense, Security

Domestic, Entertainment.

Unit No 4: Robot Kinematics and Dynamics [7 Hours]

A brief overview of Robot Kinematics and Dynamics. Kinematics- coordinate transformations, DH parameters, Forward kinematics, Inverse Kinematics, Jacobians, Statics, Trajectory Planning. Robot Control – PWM, joint motion control, feedback control, Computed torque control.

Unit No 5: Robot End-Effectors and Robot Programming [7 Hours]

Different types of grippers- Mechanical, Magnetics, vacuum, Adhesive, Gripper force Analysis & Gripper Design, Perception, Localization and mapping, Probabilistic robotics, Path planning, BFS; DFS; Dijkstra; A-star; D-star; Voronoi; Potential Field; Hybrid approaches, Simultaneous Localization and Mapping, Introduction to Reinforcement Learning.

Note: Practical should cover under Tutorial slots.Text

Books

1. Sawney A K and Puneet Sawney, ―A Course in Mechanical Measurements and Instrumentation and Control‖, 12th edition, Dhanpat Rai & Co
2. Introduction to Robotics By S.K.Saha , Tata McGraw Hill
3. KS Fu, RC Gonzalez, CSG Lee , Robotics Control ,Sensing ,Vision and Intelligence, Tata McGraw Hill

Reference Books

1. Richard Zurawski, ―Industrial Communication Technology Handbook‖ 2nd edition, CRC Press, 2015
2. Robert J. Schilling , Fundamentals of Robotics- Analysis and Control, Prentics Hall india
3. J Hirchhorn, Kinematics and Dynamics of Machinery, McGraw Hill book co.

Semester –V

Advanced JAVA

BTAIPE504D	Advanced JAVA	PEC2	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Core Java Programming

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Development of GUI applications using Abstract Windowing Toolkit (AWT), Swing and Event Handling.
2. Creating develop Web applications
3. Getting acquainted with enterprise based applications by encapsulating an application's business logic.
4. Designing applications using pre-built frameworks.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Design and develop GUI applications using Applets
CO2	Apply relevant AWT/ swing components to handle the given event.
CO3	Learn to access database through Java programs, using Java Database Connectivity (JDBC)
CO4	Invoke the remote methods in an application using Remote Method Invocation (RMI)
CO5	Develop program for client /server communication using Java Networking classes.

Course Contents:

Unit No 1: Applets and Event Handling [8 Hours]

Applet Basics Introduction, limitations of AWT, Applet architecture HTML APPLET tag Passing parameter to Appletget, DocumentBase() and getCodeBase() , Japplet: Icons and Labels Text Fields Buttons, Combo Boxes , Checkboxes, Tabbed Panes, Scroll Panes, Trees: Tables Event Handling: Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes, inner classes. The AWT class hierarchy, user interface components- labels, button, canvas, scrollbars, text components, checkbox, checkbox groups, choices, lists panels scroll pane, dialogs, menu bar, graphics, layout manager layout manager types boarder, grid, flow, card and grib bag.

Unit No 2: Advanced GUI Programming [7 Hours]

Designing Graphical User Interfaces in Java, Components and Containers, Basics of Components, Using Containers, Layout Managers, AWT Components, Adding a Menu to Window, Extending GUI Features Using Swing Components, Java Utilities (java.util Package) The Collection Framework: Collections of Objects, Collection Types, Sets, Sequence, Map, Understanding Hashing, and Use of Array List & Vector.

Unit No 3: Conventional Non-Conventional Database Programming using JDBC[7 Hours]

The Concept of JDBC, JDBC Driver Types & Architecture, JDBC Packages, A Brief Overview of the JDBC process, Database Connection, Connecting to non-conventional Databases. Java Data Based Client/server, Basic JDBC program Concept, Statement, Result Set, Prepared Statement, Callable Statement, Executing SQL commands, Executing queries.

Unit No 4: Remote Method Invocation (RMI) [7 Hours]

Remote Method Invocation: Architecture, RMI registry, the RMI Programming Model; Interfaces and Implementations; Writing distributed application with RMI, Naming services, Naming and Directory Services, Setting up Remote Method Invocation RMI with Applets, Remote Object Activation; The Roles of Client and Server, Simple Client/Server Application using RMI.

Unit No 5: Networking and Servlet [7 Hours]

The java.net package, Connection oriented transmission Stream Socket Class, creating a Socket to a remote host on a port (creating TCP client and server), Simple Socket Program Example. InetAddress, Factory Methods, Instance Methods, Inet4Address and Inet6Address, TCP/IP Client Sockets. URL, URLConnection, HttpURLConnection, The URI Class, Cookies, TCP/IP Server Sockets, Datagrams, DatagramSocket, DatagramPacket, A Datagram Example. Connecting to a Server, Implementing Servers, Sending EMail, Servlet overview the Java web server The Life Cycle of a Servlet, your first servlet.

Note: Hands-on practice of Advanced Java should cover under Tutorial slots.Text Books

1. E Balagurusamy, Programming with Java, Tata Mc Graw Hill.
2. Herbert Schildt, The Complete Reference- Java2, (Seventh Edition), Tata Mc Graw Hill.
3. Steven Holzner, Java 2 Black Book, Dream Tech Press.

Reference Books

1. Java 6 Programming, Black Book, Dreamtech
2. Java Server Programming, Java EE6 (J2EE 1.6), Black Book, Dreamtech
3. M.T. Savaliya Advanced Java Technology, Dreamtech

Semester –V

Data Mining and Warehousing

BTAIOE505A	Data Mining and Warehousing	OEC1	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Database Management Systems

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. To understand the fundamentals of Data Mining
2. To identify the appropriateness and need of mining the data
3. To learn the preprocessing, mining and post processing of the data
4. To understand various methods, techniques and algorithms in data mining

Course Outcomes:

On completion of the course, students will be able to:

CO1	Apply basic, intermediate and advanced techniques to mine the data.
CO2	Analyze the output generated by the process of data mining.
CO3	Explore the hidden patterns in the data.
CO4	Adapt to new data mining tools.
CO5	Optimize the mining process by choosing best data mining technique.

Course Contents:

Unit No 1: Introduction [8 Hours]

Data Mining, Data Mining Task Primitives, Data: Data, Information and Knowledge; Attribute Types: Nominal, Binary, Ordinal and Numeric attributes, Discrete versus Continuous Attributes; Introduction to Data Preprocessing, Data Cleaning: Missing values, Noisy data; Data integration: Correlation analysis; transformation: Min-max normalization, z-score normalization and decimal scaling; data reduction: Data Cube Aggregation, Attribute Subset Selection, sampling; and Data Discretization: Binning, Histogram Analysis.

Unit No 2: Data Warehouse *[7 Hours]*

Data Warehouse, Operational Database Systems and Data Warehouses(OLTP Vs OLAP), A Multidimensional Data Model: Data Cubes, Stars, Snowflakes, and Fact Constellations Schemas; OLAP Operations in the Multidimensional Data Model, Concept Hierarchies, Data Warehouse Architecture, The Process of Data Warehouse Design, A three-tier data warehousing architecture, Types of OLAP Servers: ROLAP versus MOLAP versus HOLAP.

Unit No 3: Measuring Data Similarity and Dissimilarity [7 Hours]

Measuring Data Similarity and Dissimilarity, Proximity Measures for Nominal Attributes and Binary Attributes, interval scaled; Dissimilarity of Numeric Data: Minskowski Distance, Euclidean distance and Manhattan distance; Proximity Measures for Categorical, Ordinal Attributes, Ratio scaled variables; Dissimilarity for Attributes of Mixed Types, Cosine Similarity.

Unit No 4: Association Rules Mining [7 Hours]

Market basket Analysis, Frequent item set, Closed item set, Association Rules, a-priori Algorithm, Generating Association Rules from Frequent Item sets, Improving the Efficiency of a-priori, Mining Frequent Item sets without Candidate Generation: FP Growth Algorithm; Mining Various Kinds of Association Rules: Mining multilevel association rules, constraint based association rule mining, Meta rule-Guided Mining of Association Rules.

Unit No 5: Classification [7 Hours]

Classification and Regression for Predictive Analysis, Decision Tree Induction, Rule-Based Classification: using IF-THEN Rules for Classification, Rule Induction Using a Sequential Covering Algorithm. Bayesian Belief Networks, Classification Using Frequent Patterns, Associative Classification, Lazy Learners-k-Nearest-Neighbor Classifiers, Case-Based Reasoning, Multiclass Classification, Semi-Supervised Classification, Reinforcement learning, Systematic Learning, Wholistic learning and multi-perspective learning.

Note: Hands-on practice should cover under Tutorial slots.Text Books

1. Han, Jiawei Kamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques”, Elsevier Publishers, ISBN:9780123814791, 9780123814807.

2. Parag Kulkarni, “Reinforcement and Systemic Machine Learning for Decision Making” by Wiley-IEEE Press, ISBN: 978-0-470-91999-6

Reference Books

1. Matthew A. Russell, "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More" , Shroff Publishers, 2nd Edition, ISBN: 9780596006068

2. Maksim Tsvetovat, Alexander Kouznetsov, "Social Network Analysis for Startups:Finding connections on the social web", Shroff Publishers , ISBN: 10: 1449306462

Semester –V

Digital Communication & Information Theory

BTAIOE505B	Digital Communication & Information Theory	OEC1	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will have an adequate background, conceptual clarity, and knowledge of appropriate solution techniques related to:

1. To provide a strong foundation of fundamental basics of Digital communication & information theory.
2. Demonstrate awareness and fundamental understanding of various pulse modulation and digital modulation techniques.
3. To impart knowledge about information and entropy.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Study basic digital modulation techniques.
CO2	Analyze the carrier modulation techniques.
CO3	Explore the the noise signals in digital communication.
CO4	Adapt to information theory.
CO5	Optimize the coding algorithms.

Unit 1: Digital Baseband Modulation Techniques and Waveform Coding Techniques

[7 Hours]

Base Band System, Formatting Textual Data, Messages, Characters & Symbols, Formatting Analog Information, PCM, Bandwidth, SNR of PCM, DPCM, DM, ADM**.**

Unit 2: Carrier Modulation Techniques [7 Hours]

Introduction to Carrier Modulation, FSK, PSK, BPSK, DPSK, QPSK, Coherent Detection and Non-Coherent Detection, Error Performance for Binary Systems, Matched filter, SNR derivation

Unit 3: Noise in digital communication [7 Hours]

Matched filter, SNR derivation, impulse response, the output of the matched filter, BER, Generalized expression of BER, BER with matched filter, BER passband, BER baseband, Probability of error examples.

Unit 4: Information Theory *[7 Hours]*

The measure of information, Joint entropy and conditional entropy, Relative entropy and mutual information, Markov sources, Source encoding, Shannon-Fano coding, and Huffman coding, Shannon's first and second fundamental theorems, Channel capacity theorem.

Unit 5: Codes **[7 Hours]**

Linear Block Coding/Decoding, Matrix description of Linear block codes, Hamming codes, optimal linear codes, Maximum Distance Separable Cyclic Codes, Polynomials, Generation of Cyclic codes, matrix description of cyclic codes

Note: Hands-on practice should cover under Tutorial slots. Text

Books:

1. Ranjan Bose, "Information Theory coding and Cryptography", McGraw-Hill Publication,
2. R. Avudaiammal, Information Coding Techniques" Second Edition. Tata McGraw-Hill 14
3. J C Moreira, P G Farrell, "Essentials of Error-Control Coding", Wiley Student Edition.
4. Simon Haykin, "Communication Systems", John Wiley & Sons, Fourth Edition
5. Amitabha Bhattacharya, "Digital Communication", TMH 2006

Reference Books:

1. Bernard Sklar, "Digital Communications fundamentals and Applications" Pearson Education, Second Edition.
2. K Sayood, "Introduction to Data Compression" 3/e, Elsevier 2006
3. Simon Haykin "Communication Systems", John Wiley& Sons, Fourth Edition.
4. A.B Carlson, "Principles of communication systems", TMH, Third Edition.
5. Taub Schilling, "Principles of Communication system", TMH, Fourth Edition.

Semester –V

Software Engineering and Testing

BTAIOE505C	Software Engineering and Testing	OEC1	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will learn:-

1. To understand software lifecycle development models.
2. To apply software requirements engineering techniques, software design principles, modelling and software testing techniques.
3. To study fundamental concepts in software testing, including software testing objectives, processes, criteria, strategies, and methods.
4. To learn planning of a test project, designing test cases and test data, conducting test operations, managing software problems and defects, and generating a test report.
5. To develop an understanding of the meaning and importance of quality in relation to software systems and the software development process.

Course Outcomes:

On completion of the course, students will be able to:

CO1	To use the techniques, skills, and modern engineering tools necessary for engineering practice.
CO2	To design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
CO3	To apply software testing knowledge and its processes to software applications.
CO4	To identify various software testing problems and solving software testing problems by designing and selecting software test models, criteria, strategies and methods.
CO5	To apply the techniques learned to improve the quality of software development.

Course Contents:

Unit No 1: **[7 Hours]**

Software crisis and myths, Software process and development: Generic view of process, Software life cycle and models, Analysis and comparison of varies models, an agile view of process. Requirements engineering tasks, Initiating requirement engineering process, Eliciting requirement, developing use-cases, Building the analysis model, Negotiating and validating requirement, Building the analysis model.

Unit No 2: *[7 Hours]*

Design process and design quality, Design concepts, Design model, Pattern based software design, Architectural design, User interface design. UML: Different methods: Rambaugh / Booch / Jakobsons, Need for standardization. Developing diagrams in UML (Use CASE, Class, Interaction, State diagrams) CASE TOOLS.

Unit No 3: *[8 Hours]*

Principles of Testing Software development life cycle model: Phases of software project, Quality, Quality assurance and quality control, Testing, Verification and validation, Process models to represent various phases, Life cycle models, Software testing life cycle.

White Box Testing (WBT) and Black Box Testing: Static testing, Structural testing, Challenges in WBT. Black box testing: Black box testing process

Unit No 4: *[7 Hours]*

Integration Testing: Definition, As a type of testing: Top-down integration, Bottom-up integration, Bidirectional integration, System integration, Choosing integration method, As a phase of testing, Scenario testing: System scenarios, Use case scenarios, Defect bash.

System and Acceptance Testing, Functional Vs non Functional, Functional system testing, Non- functional system testing, Acceptance testing.

Unit No 5: *[7 Hours]*

Performance testing, Regression testing, Internationalization testing, Adhoc testing. Factors governing performance of testing, Methodology, tools and process for performance testing. Regression Testing: Introduction, Types of Regression testing, Regression testing process. Adhoc testing: Introduction, Buddy testing, Pair testing, exploratory testing, Iterative testing, Agile and extreme testing, XP work flow, Defect seeding.

Testing Object Oriented Software: Introduction, Comparison of object oriented and procedural software, System testing example, Unit testing of classes, Tools for testing object oriented software, Testing web applications.

Note: Hands-on practice should cover under Tutorial slots.Text Books

1. Roger S. Pressman, "Software Engineering", Tata McGraw-Hill, 6th Edition, 2006.
2. G. Booch, J. Rambaugh, and I. Jacobson, "The Unified Modeling Language User Guide", Addison Wesley, 2nd Edition, 2005.
3.Srinivasan Desikan, Gopalaswamy Ramesh, "Software Testing: Principles and Practices", Pearson publication, 2nd Edition, 2006.

Reference Books

1. Shari Pfleeger, "Software Engineering", Pearson Education, 3rd Edition, 2008.
2. Ian Sommerville, "Software Engineering", Pearson Higher Education, 10th Edition, 2016.
3. Pankaj Jalote, "An Integrated Approach to Software Engineering", Springer New York, 2nd Edition, 2013.
4. Loise Tamres, "Introducing Software Testing", Pearson publication, 2002.
5. Boris Beizer, "Software Testing Techniques", Dreamtech press, 2nd Edition, 2014

Semester –V
Virtual Reality

BTAIOE505D	**Virtual Reality**	**PEC2**	**3L- 1T - 0P**	**4 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

This course is designed to give historical and modern overviews and perspectives on virtual reality. It describes the fundamentals of sensation, perception, technical and engineering aspects of virtual reality systems.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Describe how VR systems work and list the applications of VR.
CO2	Understand the design and implementation of the hardware that enables VR systems tobe built.
CO3	Understand the system of human vision and its implication on perception and rendering.
CO4	Explain the concepts of motion and tracking in VR systems.
CO5	Describe the importance of interaction and audio in VR systems.

Course Contents:

Unit No 1: Introduction to Virtual Reality: [7 Hours]

Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.

Unit No 2: Representing the Virtual World: [7 Hours]

Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR

Unit No 3: The Geometry of Virtual Worlds & The Physiology of Human Vision: [7 Hours]

Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.

Unit No 4: Visual Perception & Rendering: **[8 Hours]**

Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information

Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates.

Unit No 5: Motion & Tracking: *[7 Hours]*

Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection

Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies.

Note: Hands-on practice of Virtual Reality should cover under Tutorial slots.Text Books

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016 2.
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

Reference Books

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.
5. **http://lavalle.pl/vr/book.html**

Semester –V

Machine Learning Lab and Competitive Programming Lab

BTAIL506	**Machine Learning Lab and Competitive Programming Lab**	**LC3**	**0L-0T-4P**	**2 Credits**

Teaching Scheme	**Examination Scheme**
Practical: 04 hrs./week	Continuous Assessment 1: 30 Marks Continuous Assessment 2: 30 Marks End Semester Examination: 40 Marks

Machine Learning Lab

List of practicals:

1. Python Libraries for Data Science-
    a. Pandas Library
    b. Numpy Library
    c. Scikit Learn Library
    d. Matplotlib
2. Evaluation Metrics-
    a. Accuracy
    b. Precision
    c. Recall
    d. F1-Score
3. Train and Test Sets by Splitting Learn and Test Data.
4. Linear Regression
5. Multivariable Regression
6. Decision Tree Algorithm implementation.
7. Random Forest Algorithm implementation.
8. Naive Bayes Classification Algorithm implementation.
9. K-Nearest Neighbor Algorithm implementation.
10. SVM Algorithm implementation.

Competitive Programming Lab

1. Problems on array
2. Problems on matrix
3. Problems on string
4. Problems on Searching & Sorting
5. Problems on LinkedList
6. Problems on Binary Trees
7. Problems on Binary Search Trees
8. Problems on Greedy
9. Problems on BackTracking
10. Problems on Stacks & Queues
11. Problems on Heap
12. Problems on Graph
13. Problems on Trie
14. Problems on Dynamic Programming
15. Problems on Bit Manipulation

Note:
At least twenty five problems solving on competitive programming platforms such as https://uva.onlinejudge.org, http://hackerrank.com/, http://codechef.com/ etc.

OR
Competitive Programming Lab

1. Defining schema for applications.
2. Creating tables, Renaming tables, Data constraints (Primary key, Foreign key, Not Null), Data insertion into a table.
3. Grouping data, aggregate functions, Oracle functions (mathematical, character functions).
4. Sub-queries, Set operations, Joins.
5. Applying Data Normalization, Procedures, Triggers and Cursors on databases.
6. Assignment in Design and Implementation of Database systems or packages for applications such as office automation, hotel management, hospital management.
7. Deployment of Forms, Reports Normalization, Query Processing Algorithms in the above application project.
8. Studying Large objects – CLOB, NCLOB, BLOB and BFILE.
9. Data warehousing and Association rule mining.
10. Distributed data base Management, creating web-page interfaces for database applications using servlet.

Semester –V

Mini Project -I

BTAIM507	**MINI PROJECT-I**	**Project**	**0L-0T-4P**	**2 Credits**

Guidelines for Mini Project

The students shall study in group of two members (or individual) on some special topic beyond the scope of the syllabus under the subjects of Artificial Intelligence, Data Science, Electronics Engineering and Computer Science Engineering or inter discipline branch from current literature, by referring the current technical journal or reference books, under the guidance of the teacher.

In this subject head, it is expected that the student should complete the following tasks.

1. Identify problem statement / idea which is solving one problem preferably local problem may bein their University / College / near by vicinity.
2. Do the literature survey,
3. Design the solutions
4. Implement solution using latest technology
5. Write 20-25 pages report (use of latex is more suitable).
6. Present / demonstrate the solution in front of faculty member

The students shall prepare his report and execution of project for other students of his class in the presence of his guide and examiner. The student is permitted to use audio-visual aids or any other such teaching aids.

Continues Assessment:

The Continues Assessment for this head will consists of the report written in a technical reporting manner and execution of project will be assessed by the internal examiner appointed by the HOD of concern department of the institution.

Semester –V

Internship - II

BTAIP508	**Field Training / Internship / Industrial Training**	**Internship**	**Audit**

Guidelines for Internships

Guidelines for Field Training / Internship / Industrial Training Industrial Training:

1. To apply for a suitable Industrial Training, submit an application form to respective Organization concerned one semester before the Industrial Training Programmed commences.
2. Student can also apply through online platforms such as Internshala for industrial training.
3. Submit one copy of the offer letter for the Industrial Training to the Head of the department or Faculty coordinator (Industrial Training).
4. To complete the Industrial Training process within the specified time based on the Industrial Training Programme schedule.
5. Assessment within the Industrial Training context aims to evaluate the student's work quality and appropriateness to the field of study with reference to the learning outcomes of the Industrial Training Programme.
6. Evaluation of the students' performance should be done in the next upcoming semester.
7. Those students who fails, they can also complete online certification courses which are available at free of cost on various MOOC platforms.

Semester –VI

Deep Learning

BTAIC601	Deep learning	PCC7	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Basic Knowledge of Machine learning, Soft Computing, Data Structures, Python.

Course Objectives:

In this course, attendees will:

- Understand the context of neural networks and deep learning
- Have a working knowledge of neural networks and deep learning
- Explore the parameters for neural networks
- Use CNN and RNN for solving real world problem.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Implement deep learning models in Python using the Keras/PyTorch library and train them with real-world datasets.
CO2	Design convolution networks for image classification.
CO3	Perform regularization, training optimization, and hyperparameter selection on deep models.
CO4	Design Recurrent Neural Networks for text and sequence classification.
CO5	Apply Generative Deep Learning for Generating images

Course Contents:

Unit 1: Introduction to Neural Network [8 Hours]

Working Of Simple Artificial Neural Network, Multilayer Perceptron, Forward Propagation And Back Propagation Learning, Building Blocks of Deep Neural Networks, Optimization Techniques, Gradient Descent and its variants, Derivatives, Batch Optimization, Momentum Optimizer, RMSProp, Adam, Vectorization, Linear Regression and Logistic Regression with Deep Neural Network.

Unit 2: Convolutional Neural Network [7 Hours]

Introduction Convolutional Neural Network, Fully Connected Network vs Convolutional Neural Network , Building Blocks Of CNN: Filters, Convolution, Pooling, Activations Etc. Training Procedure of CNN, Feeding Images And Videos to CNN, Different CNN Architectures, Residual Networks, Skip Connections.

Unit 3: Transfer Learning and Effective training in Deep Net: [7 Hours]

Transfer Learning: Introduction To Transfer Learning, Need For Transfer Learning, Feature Extraction Using Transfer Learning, Fine Tuning.

Effective Training: Bias Variance Tradeoff, Dealing With Overfitting and Underfitting, Data Augmentation, Early Stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization, Regularization, Hyperparameter Tuning.

Unit 4: Deep learning for text and Sequences [7 Hours]

Introduction To Sequential/Temporal Data, Sequential Models, Introduction to Recurrent Neural Network ,Working of RNN, Representing Sequential Data using RNN, Working With Text Data, Text Generation With LSTM, LSTM And GRU, Transformer Network.

Unit 5: Generative Deep Learning [7 Hours]

Neural Stryle Transfer ,Variational Autoencoder, Generative Adversarial Network , Classical Supervised Tasks With Deep Learning, Image Denoising, Semantic Segmentation, Object Detection Etc.

Text Books

1. Francois Challot, "Deep Learning with Python", second edition.
2. Francois Challot, "Deep Learning with Pytorch", second edition

Reference Books

1. 1 Michael Nielsen, Neural Networks and Deep Learning, 2016
2. Deep Learning- Ian Goodfelllow, Yoshua Benjio, Aaron Courville, The MIT Press
3. Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc.

Semester –VI

Advanced Machine Learning

BTAIC602	Advanced Machine Learning	PCC8	3L- 0T - 0P	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Machine Learning Basics, Python Programming Language.

Course Objectives:

After completion of the course, students will learn:-

- To understand fundamental concepts of unsupervised learning and its various algorithms
- To understand Association Rules Mining and Recommendation Systems
- To apply ML algorithms on given data and interpret the results obtained
- To design appropriate ML solution to solve real world problems in AI domain

Course Outcomes:

On completion of the course, students will be able to:

CO1	Develop a good understanding of fundamental of unsupervised learning.
CO2	Formulation of Association Rules Mining and Recommendation Systems
CO3	Interpret a model using Reinforcement Learning.
CO4	Evaluate the time series data.
CO5	Design and Concrete implementations using boosting.

Course Contents:

Unit No 1: Unsupervised Learning **[7 Hours]**

Unsupervised Learning - 1

Introduction to Unsupervised Learning, Introduction to Clustering, Using K-means for Flat Clustering, KMeans Algorithm, Using KMeans from Sklearn, Implementing Fit & Predict Functions, Implementing K-Means Class

Unsupervised Learning - 2

How to choose Optimal K, Silhouette algorithm to choose K, Introduction to K Medoids, K Medoids Algorithm, Introduction to Hierarchical Clustering, Top down/Divisive Approach, Bottom up/Divisive Approach

Principal Component AnalysisPCA - 1

Intuition behind PCA, Applying PCA to 2D data, Applying PCA on 3D data, Math behind PCA, Finding Optimal Number of Features, Magic behind PCA, Dimensionality reduction

PCA - 2

PCA on Images, PCA on Olevitti Images, Reproducing Images, Eigenfaces, Classification of LFW Images

Unit No 2: Association Rules Mining and Recommendation Systems [7 Hours]

What are Association Rules, Association Rule Parameters, Calculating Association Rule Parameters, Recommendation Engines, Recommendation Engines working, Collaborative Filtering ,Content Based Filtering.

Unit No 3: Reinforcement Learning [8 Hours]

What is Reinforcement Learning, Why Reinforcement Learning, Elements of Reinforcement Learning, Exploration vs Exploitation dilemma, Epsilon Greedy Algorithm, Markov Decision Process (MDP), Q values and V values, Q – Learning, □ values.

Unit No 4: Time Series Analysis [7 Hours]

Time Series Analysis ,Importance of TSA ,Components of TSA,White Noise, AR model, MA model,ARMA model,ARIMA model,Stationarity,ACF & PACF

Unit No 5: Model Selection and Boosting [7 Hours]

Model Selection, Need of Model Selection, Cross – Validation, Boosting, Boosting Algorithms, Types of Boosting Algorithms, Adaptive Boosting.

Text Books:

1. Ethem Alpaydın, Introduction to Machine Learning, PHI, Third Edition, ISBN No. 978-81-203-5078-6
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Mcgraw-Hill, ISBN No. 0- 07-115467-1
3. Tom Mitchell, Machine Learning, Mcgraw-Hill, First Edition, ISBN No. 0-07-115467-1.
4. Giuseppe Bonaccorso, "Machine Learning Algorithms", Packt Publishing Limited, ISBN10: 1785889621, ISBN-13: 978-1785889622

Reference Books:

1.R.O. Duda, P.E. Hart, D.G. Stork, Pattern Classification, 2/e, Wiley, 2001

2. Shai shalev-Shwartz and Shai Ben-David, Understanding Machine Learning(From Theory to Algorithms), Cambridge University Press, First Edition, ISBN No. 978-1-107-51282-5.

3. A. Rostamizadeh, A. Talwalkar, M. Mohri, Foundations of Machine Learning, MIT Press.

4. A. Webb, Statistical Pattern Recognition, 3/e, Wiley, 2011.

Semester –VI

Geographic Information System

BTAIPE603A	Geographical Information System	PEC3	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Nil.

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. To understand the different components of GIS
2. To understand the different raster data file formats
3. To learn the Pre-processing of spatial datasets
4. To understand various GIS analysis

Course Outcomes:

On completion of the course, students will be able to:

CO1	Understand Geographic Information Systems
CO2	Analyze advantages and disadvantages associated with vector
CO3	Identify Spatial interpolation techniques.
CO4	Demonstrate GIS analysis-1.
CO5	Understand the applications Errors in GIS Key elements

Course Contents:

Unit 1: Introduction **[7 Hours]**

What is Geographic Information Systems? Different components of GIS, Different types of vector data, Raster data models and their types TIN data model..

Unit 2: Non Special Data *[7 Hours]*

Advantages and disadvantages associated with vector, raster and TIN Non-spatial data attributes and their type Raster data compression techniques Different raster data file formats spatial database systems and their types.

Unit 3: Pre-processing of spatial datasets **[8 Hours]**

Pre-processing of spatial datasets Different map projections, Spatial interpolation techniques Different types of resolutions Digital Elevation Model (DEM).

Unit 4: Quality Assessment *[7 Hours]*

Quality assessment of freely available DEMS GIS analysis-1

Unit 5: GIS Analysis *[7 Hours]*

GIS analysis-2 and applications Errors in GIS Key elements of maps.

Note: Hands-on practice should cover under Tutorial slots.

Text Books

1. Ian Heywood, Sarah Cornelius and Steve Carver, An Introduction to Geographical Information Systems (4th Edition) 2012.

Reference Books

1. Chang Kang-tsung (Karl), Introduction to Geographic Information Systems, 2006
2. Tor Bernhardsen Geographic Information Systems: An Introduction, May 2002

Semester –VI

Recommended Systems

BTAIPE603B	Recommended Systems	PEC3	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Basic Knowledge of Machine learning, Python.

Course Objectives:

Upon completion of this course, the student should be able to:

1. Understand basics concepts of Recommended System.
2. Apply various types of recommendation system.
3. Evaluate recommendation system.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Understand the need and challenges of Recommended Systems**.**
CO2	Apply Collaborative Filtering for recommendation.
CO3	Develop content based recommendation system.
CO4	Develop time location based recommendation system.
CO5	Evaluate recommended system using different metric.

Course Contents:

Unit 1: Introduction to Recommended Systems [7 Hours]

Introduction ,Goals of Recommender Systems ,Basic Models/types of Recommender Systems, Challenges in Recommender Systems, The Cold-Start Problem in Recommender Systems ,Attack-Resistant Recommender Systems, Privacy in Recommender Systems.

Case study: Basic recommendation system using weighted average and popularity score.

Unit 2: Collaborative Filtering [7 Hours]

Types of Collaborative Filtering: Neighborhood/memory based vs Model based. Neighborhood based Collaborative Filtering: User based Collaborative Filtering, Item based Collaborative Filtering, cold-start problem.

Model based Collaborative Filtering: Naive Bayes Collaborative Filtering, Matrix Factorization, Singular Value Decomposition, Association rule mining.

Case study: Book Recommendation using Collaborative Filtering

Unit 3: Content-Based Recommender Systems [8 Hours]

Introduction, Basic Components of Content-Based Systems, Preprocessing and Feature Extraction, Learning User Profiles and Filtering, Content-Based Versus Collaborative Recommendations, High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents,

Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity measures, ,Similarity based retrieval, Classification algorithms.
Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders
Case Study: 1.Content Based Recommendation System
2. Movie recommendation system (using K nearest Neighbor K-nearest neighbor method, using Pearson Correlation etc).

Unit 4: Time- and Location-Sensitive Recommender Systems [7 Hours]
Introduction, Temporal Collaborative Filtering, Discrete Temporal Models, Location-Aware Recommender Systems, case study.

Unit 5: Evaluating Recommender Systems [7 Hours]
Introduction, Evaluation Paradigms, General Goals of Evaluation Design , Design Issues in Offline Recommender Evaluation, Accuracy Metrics in Offline Evaluation, Limitations of Evaluation Measures.

Note: Hands-on practice of Recommender System should cover under Tutorial slots.

Text Books

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press(2011), 1st ed.
2. Aggarwal, C. C. “Recommender Systems: The Textbook”. Springer 2016. ISBN 978-3-319-29657-9

Reference Books

1.Deepak K. Agarwal, Bee-Chung Chen, ,Statistical Methods for Recommender Systems, Cambridge University Press(2016).

Semester –VI

Industry 4.0 and Automation

BTAIPE603C	**Industry 4.0 and Automation**	**PEC3**	**3L- 1T - 0P**	**4 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites:

1. Basics of Control Systems
2. Foundation of sensors and actuators
3. Fundamentals of Power Devices and Circuits

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Globalization and emerging issues of Industry 4.0
2. Internet of Things and Robotics as Pillars of Industry 4.0
3. Process control and Automation
4. Understand architecture of PLC, SCADA and DCS and their Importance in Industrial Automation

Course Outcomes:

On completion of the course, students will be able to:

CO1	Define essential elements of Industry 4.0
CO2	Describe architecture of Industrial IoT
CO3	Explain Recent Technological Components of Robots
CO4	Understand and Recognize Industrial needs of Automation
CO5	Identify and interpret the functionality of PLC, SCADA and DCS.

Course Contents:

Unit No 1: Introduction: [8 Hours]

Introduction, core idea of Industry 4.0, Globalization and Emerging Issues, The Fourth Revolution, Smart and Connected Business Perspective, Smart Factories, Technology Roadmap of for Industry 4.0, A brief overview of pillars of Industry 4.0: Internet of Things, Cloud Computing, Cybersecurity, Big Data and Analytics, Additive Manufacturing, Virtual/Augmented Reality, and Robotics.

Unit No 2: Internet of Things in Industry 4.0 [7 Hours]

Introduction to Internet of things (IoT) and Industrial Internet of Things (IIoT), IIoT Business Model and Reference Architecture, IIOT Layers: Sensing, Processing, Communication, and Analytics. Software Defined Networks.

Unit No 3: Robotics in Industry 4.0 **[7 Hours]**

Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly.

Unit No 4: Introduction to Automation **[7 Hours]**

Process control principles, Control System Evaluation, Analog control, Digital control, Architecture of Industrial Automation Systems(Automation Pyramid), Advantages and limitations of Automation, Concept and Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire & 3-Wire transmitters, Concept of VFD, Energy conservation schemes through VFD.

Unit No 5: PLC, SCADA and DCS **[7 Hours]**

Introduction to Programmable Logic Controllers (PLC), Generalized Block Diagram, and Essential components of PLC, Typical Specifications of PLC. Concept of SCADA, Architecture of SCADA, Components of SCADA Systems, human-machine interface (HMI) Basic Concept of DCS, History and Hierarchy of DCS, Basic Components of DCS as Operator Station, Control Module, and I/O module , Types of DCS, Comparison of PLC, DCS and SCADA

Note: Consider practical approach of Robotics under Practical slots.Text Books

1. Alp Ustundag, Emre Cevikacan, Industry 4.0 : Managing the Digital Transformation, Springer
2. Curtis Johnson, "Process Control Instrumentation Technology", 8th Edition, Pearson Education.
3. Madhuchhanda Mitra, Samarjit Sen Gupta, "Programmable Logic controllers and Industrial Automation", Penram International Publishing India Pvt. Ltd

Reference Books

1. Kilian, "Modern control technology: components & systems", Delmar 2nd edition.
2. R.G. Jamkar, "Industrial Automation Using PLC SCADA & DCS" Global Education Limited
3. S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Pres

Semester –VI

Web Development

BTAIPE603D	Web Development	PEC3	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Fundamentals of web essentials and markup languages
2. Use of the Client-side technologies in web development
3. Use of the Server-side technologies in web development
4. Understand the web services and frameworks

Course Outcomes:

On completion of the course, students will be able to:

CO1	Implement and analyze behavior of web pages using HTML and CSS
CO2	Apply the client-side technologies for web development
CO3	Analyze the concepts of Servlet and JSP
CO4	Analyze the Web services and frameworks
CO5	Apply the server side technologies for web development

Course Contents:

Unit No 1: Introduction to Web Essentials [7 Hours]

The internet, basic internet protocols, the world wide web, HTTP Request message, HTTP response message, web clients, web servers. **HTML**: Introduction, history and versions. **HTML Elements**: heading, paragraphs, line break, colors and fonts, links, frames, list, tables, images and forms. Difference between HTML and HTML5. **CSS:** Introduction to style sheet, CSS features, CSS core syntax, Style sheets and HTML, Style rule cascading and inheritance, text properties. Bootstrap

Unit No 2: Client-Side Technologies: JavaScript and DOM [7 Hours]

JavaScript: Introduction to JavaScript, JavaScript in perspective, basic syntax, variables and data types, statements, operators, literals, functions, objects, arrays, built in objects, JavaScript debuggers. DOM: Introduction to Document Object Model, DOM history and levels, intrinsic event handling, modifying element style, the document tree, DOM event handling, jQuery, Overview of Angular JS.

Unit No 3: Java Servlets and XML **[7 Hours]**

Servlet: Servlet architecture overview, A "Hello World" servlet, Servlet generating dynamic content, Servlet life cycle, parameter data, sessions, cookies, URL rewriting, other Servlet capabilities, data storage, Servlets concurrency, databases (MySQL) and Java Servlets. XML: XML documents and vocabularies, XML declaration, XML Namespaces, DOM based XML processing, transforming XML documents, DTD: Schema, elements, attributes. AJAX: Introduction, Working of AJAX.

Unit No 4: JSP and Web Services **[8 Hours]**

JSP: Introduction to Java Server Pages, JSP and Servlets, running JSP applications, Basic JSP, JavaBeans classes and JSP, Support for the Model-View-Controller paradigm, JSP related technologies. Web Services: Web Service concepts, writing a Java Web Service, Writing a Java web service client, Describing Web Services: WSDL, Communicating Object data: SOAP. Struts: Overview, architecture, configuration, actions, interceptors, result types, validations, localization, exception handling, annotations.

Unit No 5: Server Side Scripting Languages **[7 Hours]**

PHP: Introduction to PHP, uses of PHP, general syntactic characteristics, Primitives, operations and expressions, output, control statements, arrays, functions, pattern matching, form handling, files, cookies, session tracking, using MySQL with PHP, WAP and WML. Introduction to ASP.NET: Overview of the .NET Framework, Overview of C#, Introduction to ASP.NET, ASP.NET Controls, Web Services. Overview of Node JS.

Note: Hands-on practice of Web Development should cover under Tutorial slots.

Text Books

1. Jeffrey C. Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035
2. Robert W Sebesta, "Programming the World Wide Web , 4th Edition, Pearson education, 2008
3. Marty Hall, Larry, "Core Web Programming", Second Edition, Pearson Education, 2001, ISBN 978-0130897930.

Reference Books

1. H.M. Deitel, P.J. Deitel and A.B. Goldberg, "Internet & World Wide Web How To Program", Third Edition, Pearson Education, 2006, ISBN 978-0131752429.
2. Chris Bates, "Web Programming Building Internet Applications , 3rd Edition, Wiley India, 2006.
3. Xue Bai et al, "The web Warrior Guide to Web Programming , Thomson, 2003.

Semester –VI

Big Data Analytics

BTAIOE604A	Big Data Analytics	OEC2	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Should have knowledge of one Programming Language (Java preferably), Practice of SQL (queries and sub queries), exposure to Linux Environment

Course Objectives:

Upon completion of this course, the student should be able to

1. Understand the Big Data Platform and its Use cases
2. Provide an overview of Apache Hadoop
3. Provide HDFS Concepts and Interfacing with HDFS
4. Understand Map Reduce Jobs
5. Provide hands on Hodoop Eco System
6. Apply analytics on Structured, Unstructured Data.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Identify Big Data and its Business Implications.
CO2	List the components of Hadoop and Hadoop Eco-System
CO3	Access and Process Data on Distributed File System
CO4	Develop Big Data Solutions using Hadoop Eco System
CO5	Use Big data Framework, security and governance.

Course Contents:

Unit No 1: Introduction to Big Data and Hadoop **[7 Hours]**

Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analyzing Data with UNIX tools, Analyzing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets.

Unit No 2: HDFS (Hadoop Distributed File System): **[7 Hours]**

The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Unit No 3: Map Reduce: *[7 Hours]*

Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features, Hadoop cluster.

Unit No 4: Hadoop Eco System: [8 Hours]

Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.

Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions.

Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS.

Big SQL : Introduction

Unit No 5: Big Data Framework and security: [7 Hours]

Apache kafka: Feature, concept, architecture, components

Apache Spark: Feature, concept, architecture, components.

Kerberos authentication: Feature, concept, architecture, components

Note: Hands-on practice of to deploy Big Data systems should cover under Tutorial slots.Text Books

1. Tom White " Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012.
2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.

Reference Books

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2. Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013)
3. Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw-Hill/Osborne Media (2013), Oracle press.
4. Anand Rajaraman and Jef rey David Ulman, "Mining of Massive Datasets", Cambridge University Press, 2012.
5. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
6. Glen J. Myat, "Making Sense of Data", John Wiley & Sons, 2007
7. Pete Warden, "Big Data Glossary", O'Reily, 2011.
8. Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, 2013.

Semester –VI

Cryptography & Network Security

BTAIOE604B	Cryptography & Network Security	OEC2	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. The objectives of information security
2. Explain the importance and application of each of confidentiality, integrity, authentication and availability
3. Understand various cryptographic algorithms.
4. Understand the basic categories of threats to computers and networks
5. Describe public-key cryptosystem.
6. Describe the enhancements made to IPv4 by IPSec
7. Understand Intrusions and intrusion detection
8. Discuss the fundamental ideas of public-key cryptography.
9. Generate and distribute a PGP key pair and use the PGP package to send an encrypted email message.
10. Discuss Web security and Firewalls

Course Outcomes:

On completion of the course, students will be able to:

CO1	Understand basic cryptographic algorithms, message and web authentication and security issues.
CO2	Ability to identify information system requirements for both of them such as client and server.
CO3	Ability to understand the current legal issues towards information security.
CO4	Develop transport level security.
CO5	Apply knowledge for develop model.

Unit No 1: Security Concepts: [7 Hours]

Introduction, The need for security, Security approaches, Principles of security, Types of Security attacks, Security services, Security Mechanisms, A model for Network Security Cryptography Concepts and Techniques: Introduction, plain text and cipher text, substitution techniques, transposition techniques, encryption and decryption, symmetric and asymmetric key cryptography, steganography, key range and key size, possible types of attacks.

Unit No 2: Symmetric key Ciphers: [7 Hours]

Block Cipher principles, DES, AES, Blowfish, RC5, IDEA, Block cipher operation, Stream ciphers, RC4. Asymmetric key Ciphers: Principles of public key cryptosystems, RSA algorithm, Elgamal Cryptography, Diffie-Hellman Key Exchange, Knapsack Algorithm.

Unit No 3: Cryptographic Hash Functions, key management and distribution: [8 Hours]

Cryptographic Hash Functions: Message Authentication, Secure Hash Algorithm (SHA-512), Message authentication codes: Authentication requirements, HMAC, CMAC, Digital signatures, Elgamal Digital Signature Scheme.

Key Management and Distribution: Symmetric Key Distribution Using Symmetric & Asymmetric, Encryption, Distribution of Public Keys, Kerberos, X.509 Authentication Service, Public – Key Infrastructure.

Unit No 4: Transport-level Security: [7 Hours]

Web security considerations, Secure Socket Layer and Transport Layer Security, HTTPS, Secure Shell (SSH)

Wireless Network Security: Wireless Security, Mobile Device Security, IEEE 802.11 Wireless LAN, IEEE 802.11i Wireless LAN Security.

Unit No 5: Case Study: [7 Hours]

E-Mail Security: Pretty Good Privacy, S/MIME IP Security: IP Security overview, IP Security architecture, Authentication Header, Encapsulating security payload, Combining security associations, Internet Key Exchange

Case Studies on Cryptography and security: Secure Multiparty Calculation, Virtual Elections, Single sign On, Secure Inter-branch Payment Transactions, Cross site Scripting Vulnerability

Note: Hands-on practice should cover under Practical slots.

Text Book:

1. Cryptography and Network Security - Principles and Practice: William Stallings, Pearson Education, 6th Edition
2. Cryptography and Network Security: Atul Kahate, Mc Graw Hill, 3rd Edition

Reference Books:

1. Cryptography and Network Security: C K Shyamala, N Harini, Dr T R Padmanabhan, Wiley India, 1st Edition.
2. Cryptography and Network Security: Forouzan Mukhopadhyay, Mc Graw Hill, 3rd Edition
3. Information Security, Principles, and Practice: Mark Stamp, Wiley India.
4. Principles of Computer Security: WM. Arthur Conklin, Greg White, TMH
5. Introduction to Network Security: Neal Krawetz, CENGAGE Learning
6. Network Security and Cryptography: Bernard Menezes, CENGAGE Learning

Semester –VI

Agile Methodology

BTAIOE604C	Agile Methodology	OEC2	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will learn:-

- To provide students with a theoretical as well as practical understanding of agile software development practices and how small teams can apply them to create high-quality software.
- To provide a good understanding of software design and a set of software technologies and APIs.
- To do a detailed examination and demonstration of agile development and testing techniques.
- To understand the benefits and pitfalls of working in an agile team.
- To understand agile development and testing.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Realize the importance of interacting with business stakeholders in determining the requirements for a software system
CO2	Perform iterative software development processes: how to plan them, how to execute them.
CO3	Point out the impact of social aspects on software development success.
CO4	Develop techniques and tools for improving team collaboration and software quality.
CO5	Perform Software process improvement as an ongoing task for development teams and show agile approaches can be scaled up to the enterprise level.

Course Contents:

Unit No 1: AGILE METHODOLOGY **[7 Hours]**

Theories for Agile Management – Agile Software Development – Traditional Model vs. Agile Model - Classification of Agile Methods – Agile Manifesto and Principles – Agile Project Management – Agile Team Interactions – Ethics in Agile Teams - Agility in Design, Testing – Agile Documentations – Agile Drivers, Capabilities and Values.

Unit No 2: AGILE PROCESSES *[8 Hours]*

Lean Production - SCRUM, Crystal, Feature Driven Development- Adaptive Software Development - Extreme Programming: Method Overview – Lifecycle – Work Products, Roles and Practices.

Unit No 3: AGILITY AND KNOWLEDGE MANAGEMENT *[7 Hours]*

Agile Information Systems – Agile Decision Making - Earl_S Schools of KM – Institutional Knowledge Evolution Cycle – Development, Acquisition, Refinement, Distribution, Deployment , Leveraging – KM in Software Engineering – Managing Software Knowledge – Challenges of Migrating to Agile Methodologies – Agile Knowledge Sharing – Role of Story-Cards – Story-Card Maturity Model (SMM).

Unit No 4: AGILITY AND REQUIREMENTS ENGINEERING *[7 Hours]*

Impact of Agile Processes in RE–Current Agile Practices – Variance – Overview of RE Using Agile – Managing Unstable Requirements – Requirements Elicitation – Agile Requirements Abstraction Model – Requirements Management in Agile Environment, Agile Requirements Prioritization – Agile Requirements Modeling and Generation – Concurrency in Agile Requirements Generation.

Unit No 5: AGILITY AND QUALITY ASSURANCE *[7 Hours]*

Agile Product Development – Agile Metrics – Feature Driven Development (FDD) – Financial and Production Metrics in FDD – Agile Approach to Quality Assurance - Test Driven Development – Agile Approach in Global Software Development.

Text Books

1. David J. Anderson and Eli Schragenheim, ―Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results‖, Prentice Hall, 2003.
2. Hazza and Dubinsky, ―Agile Software Engineering, Series: Undergraduate Topics in Computer Science‖, Springer, 2009.

Reference Books

1. Craig Larman, ―Agile and Iterative Development: A Manager_s Guide‖, Addison-Wesley, 2004.
2. Kevin C. Desouza, ―Agile Information Systems: Conceptualization, Construction, and Management‖, Butterworth-Heinemann, 2007.

Semester –VI

Augmented Reality

BTAIOE604C	Augmented Reality	OEC2	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial : 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

The objective of this course is to provide a foundation to the fast growing field of AR and make the students aware of the various AR devices

Course Outcomes:

On completion of the course, students will be able to:

CO1	Describe how AR systems work and list the applications of AR.
CO2	Understand and analyse the hardware requirement of AR.
CO3	Use computer vision concepts for AR and describe AR techniques.
CO4	Analyse and understand the working of various state of the art AR devices .
CO5	Acquire knowledge of mixed reality .

Course Contents:

Unit No 1: Introduction to Augmented Reality: [7 Hours]

What Is Augmented Reality - Defining augmented reality, history of augmented reality, The Relationship Between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum Between Real and Virtual Worlds, applications of augmented reality

Augmented Reality Concepts- Augmented Reality Working, Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.

Unit No 2: Augmented Reality Hardware: [7 Hours]

Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception , Requirements and Characteristics, Spatial Display Model.

Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.

Unit No 3: Computer Vision for Augmented Reality & A.R. Software: [7 Hours]

Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking

Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.

Unit No 4: AR Techniques- Marker based & Markerless tracking: [8 Hours]

Marker-based approach- Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication Marker types- Template markers, 2D barcode markers, imperceptible markers.

Marker-less approach- Localization based augmentation, real world examples

Tracking methods- Visual tracking, feature based tracking, hybrid tracking, and initialization and recovery.

Unit No 5: AR Devices & Components: [7 Hours]

AR Components – Scene Generator, Tracking system, monitoring system, display, Game scene

AR Devices – Optical See- Through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, Video see-through systems.

Note: Hands-on practice of Augmented Reality should cover under Tutorial slots.

Text Books

2. Allan Fowler-AR Game Development‖, 1st Edition, A press Publications, 2018, ISBN 978-1484236178
3. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494.

Reference Books

1. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381
2. Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0
3. https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf
4. https://docs.microsoft.com/en-us/windows/mixed-reality/
5. https://docs.microsoft.com/en-us/archive/msdn-magazine/2016/november/hololens introduction-to-the-hololens

Semester –VI
Development Engineering

BTAIHM605A	**Development Engineering**	**HSSMEC5**	**3L- 0T - 0P**	**3 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:
After completion of the course, students will learn:-

Course Outcomes:
On completion of the course, students will be able to:

CO1	Improve the skills of development engineering
CO2	Get the knowledge of world poverty and development
CO3	Aware about social justice
CO4	Apply development strategies
CO5	Understand engineering for sustainable community development

Course Contents:

Unit No 1: Introduction **[7 Hours]**
Introduction, Various Definitions of Development Engineering.

Unit No 2: World Poverty and Development **[8 Hours]**
World Poverty and Development, Poverty in the India, Sustainable Development, Culture and Global Competence, The Engineer‘s Role.

Unit No 3: Social Justice *[7 Hours]*
Social Justice, Social Justice and Engineering, Religious Perspectives, Secular Perspectives.

Unit No 4: Development Strategies **[7 Hours]**
Development Strategies: Society, Technological Change, and Development, Development Economists‘ Perspectives, Global Health Perspective, International Education Perspective, Social Business Perspectives.

Unit No 5: Engineering for Sustainable Community Development **[7 Hours]**
The Engineer as a Helper Participatory Community Development, Teamwork and Project Management, Community Assessment: Learning About a Community, Project Selection, Humanitarian Technology, Participatory Technology Development, Humanitarian STEM Education. ICT for Development, AI for Humanitarian purposes, Blockchain and Social Development.

Text Books

1. Kevin M. Passino, Humanitarian Engineering: Advancing Technology for Sustainable Development

Semester –VI

Employability and Skill Development

BTAIHM605B	**Employability and Skill Development**	**HSSMEC5**	**3L- 0T - 0P**	**3 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:

After completion of the course, students will learn:-

Course Outcomes:

On completion of the course, students will be able to:

CO1	Improve the soft skills and communication.
CO2	Empower Arithmetic and Mathematical Reasoning and Analytical Reasoning and Quantitative Ability
CO3	Use of grammar.
CO4	Development in interview skills.
CO5	Develop problem solving techniques.

Course Contents:

Unit No 1: Soft Skills & Communication basics: [7 Hours]

Soft skills Vs hard skills, Skills to master, Interdisciplinary relevance, Global and national perspectives on soft skills, Resume, Curriculum vitae, How to develop an impressive resume, Different formats of resume Chronological, Functional, Hybrid, Job application or cover letter, Professional presentation- planning, preparing and delivering presentation, Technical writing.

Unit No 2: Arithmetic and Mathematical Reasoning and Analytical Reasoning and Quantitative Ability [8 Hours]

Aspects of intelligence, Bloom taxonomy, multiple intelligence theory, Number sequence test, mental arithmetic (square and square root, LCM and HCF, speed calculation, reminder theorem).

Matching, Selection, Arrangement, Verifications (Exercises on each of these types).

Verbal aptitude (Synonym, Antonym, Analogy).

Unit No 3: Grammar and Comprehension [7 Hours]

English sentences and phrases, Analysis of complex sentences, Transformation of sentences, Paragraph writing, Story writing, Reproduction of a story, Letter writing, précis writing, Paraphrasing and e-mail writing.

Unit No 4: Skills for interviews **[7 Hours]**

Interviews- types of interviews, preparatory steps for job interviews, interview skill tips, Group discussion- importance of group discussion, types of group discussion, difference between group discussion, panel discussion and debate, personality traits evaluated in group discussions, tips for successful participation in group discussion, Listening skills- virtues of listening, fundamentals of good listening, Non-verbal communication-body movement, physical appearance, verbal sounds, closeness, time.

Unit No 5: Problem Solving Techniques **[7 Hours]**

Problem solving model: 1. Define the problem, 2. Gather information, 3. Identify various solution, 4. Evaluate alternatives, 5. Take actions, 6. Evaluate the actions.

Problem solving skills: 1. Communicate. 2. Brain storming, 3. Learn from mistakes.

Text Books

1. R. Gajendra Singh Chauhan, Sangeeta Sharma, ―Soft Skills- An integrated approach to maximize personality‖, ISBN: 987-81-265-5639-7, First Edition 2016

Reference Books

1. Wiley Wren and Martin, "English grammar and Composition", S. Chand publications.
2. R. S. Aggarwal, "A modern approach to verbal reasoning", S. Chand publications.
3. Philip Carter, "The Complete Book of Intelligence Test", John Willey & Sons Ltd.
4. Philip Carter, Ken Russell, "Succeed at IQ test", Kogan Page.
5. Eugene Ehrlich, Daniel Murphy, "Schaum;s Outline of English Grammar", McGraw Hills.
6. David F. Beer, David A. McMurrey, ―A Guide to Writing as an Engineer‖, ISBN: 978- 1-118- 30027-5 4th Edition, 2014, Wiley.

Semester –VI

Consumer Behavior

BTAIHM605C	**Consumer Behavior**	**HSSMEC5**	**3L- 0T - 0P**	**3 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:
After completion of the course, students will learn:-

Course Outcomes:
On completion of the course, students will be able to:

CO1	Study of Consumer Behavior
CO2	Get Market Segmentation and Positioning
CO3	Develop Models of Consumer Behavior
CO4	Analyze Psychological Influences on Consumer Decision Making
CO5	Study Diffusion of innovation Diffusion Process

Course Contents:

Unit No 1: Introduction to the Study of Consumer Behavior: [7 Hours]
Defining Consumer Behavior, Scope and Application of Consumer Behavior, Why Study Consumer Behavior, Evolution of Consumer Behavior as a Field Of Study and its relationship with Marketing: Behavioral Dimension, The Interdisciplinary Nature of Consumer Behavior. Market Research and Consumer Behavior, Relevance of Market Research with Consumer Behavior, Approaches to Consumer Behavior Research, Quantitative Research, Qualitative Research.

Unit No 2: Market Segmentation and Positioning [8 Hours]
Market Segmentation, Basis for Segmentation, Alternatives available for Segmentation, Positioning. The Consumer Decision Making Process: Buying Motives, Buying Roles, Consumer Decision Making Process, Levels of Consumer Decision Making, Perspectives to Consumer Decision Making, Consumer Decision Making Process.

Unit No 3: Models of Consumer Behavior [7 Hours]
The Economic model, Learning model, Psychoanalytic model, The sociological model. The Howard Sheth model of Buying Behaviour, The Nicosia model, The Engel - Kollat - Blackwell Model, Engel, Blackwell and Miniard (EBM) model.

Unit No 4: Psychological Influences on Consumer Decision Making [7 Hours]

Consumers Needs & Motivation, Emotions and Mood, Consumer Involvement, Consumer Learning, Personality, Self-concept and Self-image, Consumer Perception, Risk and Imagery. Consumer Attitude: Belief, Affect, Attitude and Intention, Attitude Formation and Attitude Change, Consumer Communication. Sociological Influences on Consumer Decision Making: Consumer groups, Consumer reference groups, Family and Life cycle, Social class and mobility, lifestyle analysis, Culture; Sub-Culture, Cross Culture, Interpersonal Communication and influence, Opinion Leadership.

Unit No 5: Diffusion of innovation Diffusion Process [7 Hours]

Adoption Process, Consumer Innovators, Multiplicative innovation adoption (MIA) model. Organizational Buying: Differences between Industrial Markets and Consumer Markets, Differences between Organizational and Consumer Buying, Buying Decisions in Organizational Buying Process, Types of Decision Making, Organization Buyer's Decision Making Process, and Factors influencing Organizational Buying Behaviour, Decision Makers in Organizational Buying, Webster and Wind model of Organizational buying behaviour, The Sheth model of Industrial buying, The Sheth model of Industrial buying Consumer Behavior Analysis and Marketing Strategy: Consumer Behavior and Product Strategy, Consumer Behavior and Pricing Strategy, Consumer Behavior and Distribution Channel Strategy, Consumer Behavior and Promotion Strategy.

Text Books

1. Consumer Behavior, Schiffman, L.G. and Kanuk L.L., Prentice Hall, India.

Reference Books

1. Consumer Behavior, Concepts and Applications, Loudon, D.L. and Bitta, A.J.D, TatacGrawHill.
2. Consumer Behavior and Marketing Startegy, Peter, J.P. and Olson, J.C., Schiffman, L.G. andKanuk L.L., Prentice Hall, India.

Semester –VI

Deep Learning and Advanced Machine Learning Lab

BTAIL606	Deep Learning and Advanced Machine Learning Lab	LC4	0L-0T-4P	2 Credits

Teaching Scheme	Examination Scheme
Practical: 04 hrs./week	Continuous Assessment 1: 30 Marks Continuous Assessment 2: 30 Marks End Semester Examination: 40 Marks

Deep Learning Lab

Practical List

1. Loading dataset into keras/pytorch, creating training and testing splits.
2. Creating functions to compute various losses.
3. Feeding data to pretrained neural network and making predictions.
4. Implementing regression using deep neural network.
5. Classifying IMDB movie review dataset using deep neural network-binary classification problem.
6. Classifying Reuters dataset using deep neural network-multiclass classification problem.
7. Classifying MNIST Dataset using CNN.
8. Classifying data using pretrained models/transfer learning.
9. Training various popular neural networks (Resnet, VGGNet,InceptionV3 etc) on custom Dataset.
10. Tempreture forecasting using RNN.
11. Implementation of GAN on any suitable dataset.

Advanced Machine Learning Lab

1. Implementing K-means Clustering.
2. Implementing Hierarchical Clustering.
3. Implementation of Apriori Algorithm.
4. Implementation of Market Basket Analysis.
5. Reinforcement Learning-
    a. Calculating Reward
    b. Discounted Reward
    c. Calculating Optimal quantities
    d. Implementing Q Learning
    e. Setting up an Optimal Action
6. Time Series Analysis-
    a. Checking Stationary
    b. Converting a non-stationary data to stationary
    c. Implementing Dickey Fuller Test
    d. Plot ACF and PACF
    e. Generating the ARIMA plot
    f. TSA Forecasting
7. Boosting
    a. Cross Validation
    b. AdaBoost

Semester –VI

Mini Project -II

BTAIM607	**MINI PROJECT-II**	**Project**	**0L-0T-4P**	**2 Credits**

Guidelines for Mini Project

The students shall study in group of two members (or individual) on some special topic beyond the scope of the syllabus under the subjects of Artificial Intelligence, Data Science, Electronics Engineering and Computer Science Engineering or inter discipline branch from current literature, by referring the current technical journal or reference books, under the guidance of the teacher.

In this subject head, it is expected that the student should complete the following tasks.

1. Identify problem statement / idea which is solving one problem preferably local problem may bein their University / College / nearby vicinity.
2. Do the literature survey,
3. Design the solutions
4. Implement solution using latest technology
5. Write 20-25 pages report (use of latex is more suitable).
6. Present / demonstrate the solution in front of faculty member

The students shall prepare his report and execution of project for other students of his class in the presence of his guide and examiner. The student is permitted to use audio-visual aids or any other such teaching aids.

Continues Assessment:

The Continues Assessment for this head will consists of the report written in a technical reporting manner and execution of project will be assessed by the internal examiner appointed by the HOD of concern department of the institution.

Semester –VI

Internship - III

BTAIP608	**Field Training / Internship / Industrial Training**	**Internship**	**Audit**

Guidelines for Internships

Guidelines for Field Training / Internship / Industrial Training Industrial Training:

1. To apply for a suitable Industrial Training, submit an application form to respective Organization concerned one semester before the Industrial Training Programmed commences.
2. Student can also apply through online platforms such as Internshala for industrial training.
3. Submit one copy of the offer letter for the Industrial Training to the Head of the department or Faculty coordinator (Industrial Training).
4. To complete the Industrial Training process within the specified time based on the Industrial Training Programme schedule.
5. Assessment within the Industrial Training context aims to evaluate the student's work quality and appropriateness to the field of study with reference to the learning outcomes of the Industrial Training Programme.
6. Evaluation of the students' performance should be done in the next upcoming semester.
7. Those students who fails, they can also complete online certification courses which are available at free of cost on various MOOC platforms.

COURSE CURRICULUM MAPPING WITH MOOC PLATFORM NPTEL

Sr. No	Name of Subject as per Curriculum	Course Code	Semester	SWAYAM/ NPTEL Course And Web Link	Name of Institute offering course	Relevance %	Duration of Course
1	Computer Network and Cloud Computing	BTAIC501	V	Cloud computing https://onlinecourses.nptel.ac.in/noc22_cs87/preview Computer Networks and Internet Protocol https://onlinecourses.nptel.ac.in/noc22_cs19/preview	IIT Kharagpur	60 %	12 weeks
2	Machine Learning	BTAIC502	V	Introduction to machine learning https://onlinecourses.nptel.ac.in/noc22_cs97/preview	IIT Kharagpur	80 %	8 weeks
	Knowledge reasoning and AI ethics	BTAIHM503	V	Artificial intelligence: knowledge representation and reasoning https://nptel.ac.in/courses/106106140	IIT Madras	60 %	12 weeks
4	Virtual Reality	BTAIPE504A	V	Virtual reality engineering https://nptel.ac.in/courses/121106013	IIT Madras	70 %	12Weeks
5	Soft computing	BTAIPE504B	V	Introduction to soft computing https://onlinecourses.nptel.ac.in/noc22_cs54/preview	IIT Kharagpur	40 %	8 Weeks
6				Neural networks and applications https://archive.nptel.ac.in/courses/117/105/117105084/	IIT Kharagpur	40 %	37 lectures
7	Sensors and Robotics Technology	BTAIPE504C	V	Introduction to robotics https://onlinecourses.nptel.ac.in/noc22_de11/preview Introduction to robotics https://archive.nptel.ac.in/courses/107/106/107106090/	IIT Madras	70 %	12 weeks
8	Advanced Java	BTAIPE504D	V	Programming in Java https://onlinecourses.nptel.ac.in/noc22_cs47/preview	IIT Kharagpur	50 %	12 weeks
9	Data mining and warehousing	BTAIOE505A	V	Data mining https://onlinecourses.swayam2.ac.in/cec19_cs01/preview		60 %	12 weeks
10				Data mining https://onlinecourses.nptel.ac.in/noc21_cs06/preview	IIT Kharagpur	40 %	8 weeks
11	Digital communication and information theory	BTAIOE505B	V	An introduction to coding theory https://onlinecourses.nptel.ac.in/noc22_ee108/preview	IIT Kanpur	80 %	12 weeks
12				Principles of Digital communication https://nptel.ac.in/courses/108101113	IIT Bombay	90 %	12 weeks
13	Software engineering and testing	BTAIOE505C	V	Software engineering https://onlinecourses.nptel.ac.in/noc22_cs106/preview	IIT Kharagpur	60 %	12 weeks
14				Software testing https://onlinecourses.nptel.ac.in/noc19_cs71/preview	IIT Bangalore	60 %	12 weeks
15				Software testing https://onlinecourses.nptel.ac.in/noc20_cs19/preview	IIT Kharagpur	40 %	4 weeks
16	Deep learning	BTAIC601	VI	Deep learning https://onlinecourses.nptel.ac.in/noc20_cs62/preview	IIT Kharagpur	80 %	12 week
17				Deep learning https://onlinecourses.nptel.ac.in/noc22_cs124/preview	IIT Ropar	70 %	12 weeks
18	Advanced Machine Learning	BTAIC602	VI	Machine learning for engineering and science application https://onlinecourses.nptel.ac.in/noc19_cs82/preview	IIT Madras	50 %	12 Weeks
19	Augmented reality	BTAIPE603A	VI	-			
20	Recommender system	BTAIPE603B	VI	-			

21	Industry 4.0 & automation	BTAIPE603 C	VI	Introduction to industry 4.0 and industrial internet of things https://onlinecourses.nptel.ac.in/noc22_cs95/preview	IIT Kharagpur	50 %	12 weeks
22	Web Development	BTAIPE603 D	VI	Modern application development https://nptel.ac.in/courses/106106156	IIT Madras	40 %	8 weeks
23	Big Data Analytics	BTAIOE604 A	VI	-			
24	Cryptography and network security	BTAIOE604 B	VI	Cryptography and network security https://onlinecourses.nptel.ac.in/noc22_cs90/preview	IIT Kharagpur	60 %	12 weeks
25	Agile Methodology	BTAIOE604 C	VI	-			
26	Development Engineering	BTAIHM605 A	VI	Developing soft skill and personality https://archive.nptel.ac.in/courses/109/104/109104107/ Educational leadership https://archive.nptel.ac.in/courses/109/105/109105122/	IIT Kharagpur & Kanpur	40 %	8 weeks
27	Employability and Skills Development	BTAIHM605 B	VI	Soft skills https://onlinecourses.nptel.ac.in/noc21_hs76/preview	IIT Roorkee	70 %	12 weeks
28	Consumer Behavior	BTAIHM605 C	VI	Introduction to consumer behavior https://nptel.ac.in/courses/110105029	IIT Kharagpur	50 %	8 weeks
29	Economics and management	BTAIHM605 D	VI	Economics / Management / Entrepreneurship https://nptel.ac.in/courses/110105067	IIT Kharagpur	60 %	12 weeks

COURSE CURRICULUM MAPPING WITH MOOC PLATFORM COURSERA

Sr. No	Name of Subject as per Curriculum	Course Code	Semester	Coursera Course And Web Link	Name of Institute offering course	Relevance %	Duration of Course
1	Computer Network and Cloud Computing	BTAIC501	V	The Bits and Bytes of Computer Networking https://www.coursera.org/learn/computer-networking	Google Career Certificate	80%	6 Weeks
2				Introduction to Cloud Computing https://www.coursera.org/learn/introduction-to-cloud	IBM Cloud	75%	5 Weeks
3	Machine Learning	BTAIC502	V	Machine Learning for All https://www.coursera.org/learn/uol-machine-learning-for-all	University of London	90%	4 Weeks
4	Knowledge reasoning and AI ethics	BTAIHM503	V	Artificial Intelligence Ethics in Action https://www.coursera.org/learn/ai-ethics-analysis	LearnQuest	75%	3 Weeks
5	Virtual Reality	BTAIPE504A	V	Intro to AR/VR/MR/XR: Technologies, Applications & Issues https://www.coursera.org/learn/intro-augmented-virtual-mixed-extended-reality-technologies-applications-issues	University of Michigan	78%	4 Weeks
6	Soft computing	BTAIPE504B	V	Neural Networks and Deep Learning https://www.coursera.org/learn/neural-networks-deep-learning	DeepLearning.AI	65%	4 Weeks
7	Sensors and Robotics Technology	BTAIPE504C	V	AI For Everyone https://www.coursera.org/learn/ai-for-everyone	DeepLearning.AI	65%	4 Weeks

8	Advanced Java	BTAIPE 504D	V	Object Oriented Programming in Java https://www.coursera.org/learn/object-oriented-java	UC San Diego	75%	6 Weeks
9	Data mining and warehousing	BTAIOE 505A	V	Data Mining Pipeline https://www.coursera.org/learn/data-mining-pipeline	University of Colorado Boulder	85%	4 Weeks
10				Fundamentals of Data Warehousing https://www.coursera.org/learn/fundamentals-of-data-warehousing	LearnQuest	80%	3 Weeks
11	Digital communication and information theory	BTAIOE 505B	V	Fundamentals of Network Communication https://www.coursera.org/learn/fundamentals-network-communications	University of Colorado	76%	5 Weeks
12				Cryptography and Information Theory https://www.coursera.org/learn/crypto-info-theory	University of Colorado	80%	4 Weeks
13	Software engineering and testing	BTAIOE 505C	V	Software Engineering: Implementation and Testing https://www.coursera.org/learn/software-engineering-implementation-and-testing	The Hong Kong University of Science and Technology	90%	7 Weeks
14	Deep learning	BTAIC601	VI	Neural Networks and Deep Learning https://www.coursera.org/learn/neural-networks-deep-learning	DeepLearning.AI	80%	4 Weeks
15	Advanced Machine Learning	BTAIC602	VI	Advanced Machine Learning and Signal Processing https://www.coursera.org/learn/advanced-machine-learning-signal-processing	IBM Skills Network	80%	4 Weeks
16	Augmented reality	BTAIPE 603A	VI	Introduction to Augmented Reality and ARCore https://www.coursera.org/learn/ar	Daydream	85%	4 Weeks
17	Recommender system	BTAIPE603B	VI	Basic Recommender Systems https://www.coursera.org/learn/basic-recommender-systems	EIT Digital	70%	4 Weeks
18	Industry 4.0 & automation	BTAIPE 603C	VI	Industrial Internet of Things (IIoT) https://www.coursera.org/learn/industrial-internet-of-things	University of Michigan	80%	4 Weeks
19	Web Development	BTAIPE 603D	VI	Web Application Development: Basic Concepts https://www.coursera.org/learn/web-app	University of New Mexico	80%	5 Weeks
20	Big Data Analytics	BTAIOE 604A	VI	Fundamentals of Software Architecture for Big Data https://www.coursera.org/learn/software-architecture-for-big-data-fundamentals	University of Colorado Boulder	75%	4 Weeks
21	Cryptography and network security	BTAIOE 604B	VI	Cryptography and Hashing Overview https://www.coursera.org/learn/crypto-hashing	University of California, Irvine	75%	4 Weeks
22	Agile Methodology	BTAIOE 604C	VI	Combining Scrum with Other Agile Methodologies https://www.coursera.org/learn/combining-scrum-with-other-methodologies	LearnQuest	85%	2 Weeks
23	Humanities and Social Sciences including Management Elective Course	BTAIHM605	VI	People and Soft Skills Assessment https://www.coursera.org/learn/people-soft-skills-assessment	IBM	65%	1 Week

	(HSSMEC) – II						
24	Development Engineering	BTAIH M605A	VI	Developing a Systems Mindset https://www.coursera.org/learn/systems-mindset	University of Colorado Boulder	60%	3 Weeks
25	Employability and Skills Development	BTAIH M605B	VI	Learning How to Learn: Powerful mental tools to help you master tough subjects https://www.coursera.org/learn/learning-how-to-learn	Deep Teaching Solutions	65%	4 Weeks
26	Consumer Behavior	BTAIH M605C	VI	Market Research and Consumer Behavior https://www.coursera.org/learn/market-research	IE Business School	70%	4 Weeks
27	Economics and management	BTAIH M605D	VI	The Strategist's Challenge https://www.coursera.org/learn/strategists-challenge	University of Virginia Darden School Foundation	75%	4 Weeks

COURSE CURRICULUM MAPPING WITH MOOC PLATFORM Edx

Sr. No	Name of Subject as per Curriculum	Course Code	Semester	Edx Course And Web Link	Name of Institute offering course	Relevance %	Duration of Course
1	Computer Network and Cloud Computing	BTAIC501	V	Cloud computing https://onlinecourses.nptel.ac.in/noc22_cs87/preview 11Computer Networks and Internet Protocol https://onlinecourses.nptel.ac.in/noc22_cs19/preview	IIT Kharagpur	40%	12 weeks
2	Machine Learning Knowledge reasoning and AI ethics	BTAIC502 BTAIHM503	V V	Introduction to machine learning https://onlinecourses.nptel.ac.in/noc22_cs97/preview	IIT Kharagpur	80%	8 weeks
				Artificial intelligence: knowledge representation and reasoning https://nptel.ac.in/courses/106106140	IIT Madras	60%	12 weeks
3	Virtual Reality Soft computing	BTAIPE504A BTAIPE504B	V V	Virtual reality engineering https://nptel.ac.in/courses/121106013	IIT Madras	70%	12Weeks 8 Weeks
				Introduction to soft computing https://onlinecourses.nptel.ac.in/noc22_cs54/preview	IIT Kharagpur	40%	
4	Data Analysis	BTAI401	IV	Neural networks and applications https://archive.nptel.ac.in/courses/117/105/117105084/	IIT Kharagpur	40%	37 lectures
5	Sensors and Robotics Technology	BTAIPE504C	V	Introduction to robotics https://onlinecourses.nptel.ac.in/noc22_de11/preview Introduction to robotics https://archive.nptel.ac.in/courses/107/106/107106090/	IIT Madras	70%	12 weeks
6	Advanced Java	BTAIPE504D	V	Programming in Java https://onlinecourses.nptel.ac.in/noc22_cs47/preview	IIT Kharagpur	50%	12 weeks
7	Data mining and warehousing	BTAIOE505A	V	Data mining https://onlinecourses.swayam2.ac.in/cec19_cs01/preview		60%	12 weeks
8	Internet of Things & Embedded System Digital communication and information theory	BTSE405B BTAIOE505B	IV V	Data mining https://onlinecourses.nptel.ac.in/noc21_cs06/preview	IIT Kharagpur	40%	8 weeks
				An introduction to coding theory https://onlinecourses.nptel.ac.in/noc22_ee108/preview	IIT Kanpur	80%	12 weeks

	Programming in JAVA	BTSE405D	IV	Principles of Digital communication https://nptel.ac.in/courses/108101113	IIT Bombay	90%	12 weeks
9	Software engineering and testing	BTAIOE505C	V	Software engineering https://onlinecourses.nptel.ac.in/noc22_cs106/preview	IIT Kharagpur	60%	12 weeks
	Programming in JAVA	BTSE405D	IV	Software testing https://onlinecourses.nptel.ac.in/noc19_cs71/preview	IIT Bangalore	60%	12 weeks
10	Computer Network and Cloud Computing	BTAIC501	V	Software testing https://onlinecourses.nptel.ac.in/noc20_cs19/preview	IIT Kharagpur	40%	4 weeks
11	Deep learning	BTAIC601	VI	Deep learning https://onlinecourses.nptel.ac.in/noc20_cs62/preview	IIT Kharagpur	80%	12 week
12	Knowledge reasoning and AI ethics	BTAIHM503	V	Deep learning https://onlinecourses.nptel.ac.in/noc22_cs124/preview	IIT Ropar	70%	12 weeks
13	Advanced Machine Learning	BTAIC602	VI	Machine learning for engineering and science application https://onlinecourses.nptel.ac.in/noc19_cs82/preview	IIT Madras	50%	12 Weeks
14	Augmented reality Recommender system	BTAIPE603A BTAIPE603B	VI VI	- -			
15	Industry 4.0 & automation	BTAIPE603C	VI	Introduction to industry 4.0 and industrial internet of things https://onlinecourses.nptel.ac.in/noc22_cs95/preview	IIT Kharagpur	50%	12 weeks
16	Web Development	BTAIPE603D	VI	Modern application development https://nptel.ac.in/courses/106106156	IIT Madras	40%	8 weeks
17	Cryptography and network security	BTAIOE604A BTAIOE604B	VI VI	- Cryptography and network security https://onlinecourses.nptel.ac.in/noc22_cs90/preview	IIT Kharagpur	60%	12 weeks
18	Agile Methodology Humanities and Social Sciences including Management Elective Course (HSSMEC) – II	BTAIOE604C BTAIHM605	VI VI	- Developing soft skill and personality https://archive.nptel.ac.in/courses/109/104/109104107/ Educational leadership https://archive.nptel.ac.in/courses/109/105/109105122/	IIT Kharagpur & Kanpur	40%	8 weeks
17	Development Engineering Employability and Skills Development Consumer Behavior	BTAIHM605A BTAIHM605B BTAIHM605C	VI VI VI	- Soft skills https://onlinecourses.nptel.ac.in/noc21_hs76/preview Introduction to consumer behavior https://nptel.ac.in/courses/110105029	IIT Roorkee IIT Kharagpur	70% 50%	12 weeks 8 weeks
18	Economics and management	BTAIHM605D	VI	Economics / Management / Entrepreneurship https://nptel.ac.in/courses/110105067	IIT Kharagpur	60%	12 weeks

Semester –VII
Natural Language Processing

BTAIC701	**Natural Language Processing**	**PCC9**	**3L- 1T - 0P**	**4 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: None

Course Objectives:
To explore Natural Language Processing (NLP) methods and applications, gaining insights into language understanding, sentiment analysis, and text generation for innovative advancements.

Course Outcomes:
On completion of the course, students will be able to:

CO1	Understand the basics of Natural language processing.
CO2	Analyze the different language models and vector semantics.
CO3	Understand the sequence labelling for text analysis.
CO4	Implement text classification and sentiment analysis systems.
CO5	Implement recurrent network for language models and illustrate the NLP applications.

Course Contents:

Unit No 1: Introduction to NLP [7 Hours]
Definition and scope of NLP, Applications and real-world examples of NLP, Linguistic Fundamentals, Regular Expressions, Words, Corpora, Text Normalization: Tokenization and segmentation, Stop word removal, Stemming and lemmatization, Handling capitalization and punctuation, Minimum Edit distance.

Unit No 2: Language Models and Vector Semantics [8 Hours]
N-gram models, Language model evaluation, Smoothing techniques, Information Retrieval, Vector space models, Term frequency-inverse document frequency (TF-IDF), Pointwise Mutual Information, Applications of the TF-IDF or PPMI vector models, Word2vec, Relevance ranking algorithms.

Unit No 3: Sequence Labeling [7 Hours]
Text Preprocessing, Context-Free Grammars, Part-of-speech tagging, HMM Tagging, CRF, Named entity recognition, Evaluation of Named Entity Recognition. Syntax and Parsing,

Parsing techniques: dependency parsing, constituency parsing, Maximum Entropy Markov Models.

Unit No 4: Text Classification and Sentiment Analysis [7 Hours]

Classifiers for text classification and sentiment analysis, Optimizing Sentiment Analyzer, Other text classification tasks and the Language Model, Text Classification with Logistic Regression Model, Multinomial logistic regression, Cross-entropy loss function, Gradient Descent, Regularization, Interpreting model.

Unit No 5: Deep Learning for NLP Applications [7 Hours]

Simple Recurrent Networks, Applications of RNNs, Deep Networks: Stacked and Bidirectional RNNs, Managing Context in RNNs: LSTMs and GRUs, The Encoder-Decoder Model with RNNs, Words, Characters and Byte-Pairs, Transformers and Pretrained Language Models, Fine-Tuning and Masked Language Models

CASE STUDY: ChatGPT, GPT, AI Powered Tools, Sentiment Classification, Dialog Systems, Chatbots, Movie review system, Text Summarization, Language Translation, Question Answering and Information Retrieval, Automatic Speech Recognition, Text-to-Speech Conversion, Speech to Text Conversion.

Text Books

1. "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition" by Daniel Jurafsky and James H. Martin.
2. "Foundations of Statistical Natural Language Processing" by Christopher D. Manning and Hinrich Schutze.

Reference Books

1. "Natural Language Processing with Python" by Steven Bird, Ewan Klein, and Edward Loper.
2. "Natural Language Processing: Python and NLTK" by Jacob Perkins.
3. “Sentiment Analysis and Opinion Mining” by Bing Liu.

Semester –VII
Advanced Computer Vision

BTAIC702	**Advanced Computer Vision**	**PCC10**	**3L- 1T - 0P**	**4 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Basic knowledge of linear algebra and calculus, Image processing fundamentals, Programming skills in Python.

Course Objectives:
To acquire a comprehensive understanding of Computer Vision principles and techniques, enabling the development of advanced image processing, recognition systems, and visual perception applications

Course Outcomes:
On completion of the course, students will be able to:

CO1	Demonstrate a solid understanding of fundamental computer vision & image processing concepts.
CO2	Apply various computer vision algorithms and techniques in image processing.
CO3	Apply various computer vision algorithms and techniques to solve real-world engineering problems, such as object recognition, motion analysis, and texture.
CO4	Analyze and interpret results obtained from computer vision algorithms, and critically evaluate their performance and limitations
CO5	Implement and evaluate computer vision algorithms using programming languages and libraries commonly used in the field, such as Python and OpenCV

Course Contents:

Unit No 1: Introduction to Computer Vision & Image Processing [7 Hours]

Introduction to computer vision and its applications, Image representation, image processing operations, Image filtering & convolution.

Image enhancement: Contrast stretching, Histogram specification, Adaptive Histogram Equalization (AHE), Wavelet-based enhancement.

Image Filtering: Smoothing: Linear Filter (Box filter, Gaussian Filter) & Non-linear Filter: Median, Mini. & Max.), Sharpening: Laplacian Filter.

Unit No 2: Image Transformation & Restoration: [7 Hours]

Image Transformation: Definition & its properties (scaling, rotation), DFT, DCT, DST, Walsh-Hadamard Transform, Slant Transform, Haar Transform.

Image Restoration: Noise model, Types of Noise: Gaussian, Rayleigh, Erlang, Exponential, Uniform, salt & Pepper noise. Restoration Filtering: Mean Filter (Arithmetic, Geometric, Hormonic, Contrahamonic), Median Filter, Midpoint Filter.

Unit No 3: Segmentation, Texture & Motion Analysis [8 Hours]

Segmentation: Edge Detection (Prewitt, Sobel, Canny), Optimum Edge Detection, Thresholding techniques, Region-based segmentation.

Texture Analysis: Introduction to texture in images, Statistical texture analysis methods: Gray Level Co-occurrence Matrix (GLCM), Local Binary Patterns (LBP); Filter-based texture analysis methods: Gabor filters, Laws' texture energy measures; Texture-based segmentation.

Motion Analysis: Optical flow estimation, Lucas-Kanade method, Horn-Schunck method, Background subtraction, Dense optical flow using Deep Learning (FlowNet), Motion-based segmentation.

Unit No 4: Feature Matching Algorithms [7 Hours]

Feature Extraction: SIFT (Scale-Invariant Feature Transform), SURF (Speeded-Up Robust Features), BRISK (Binary Robust Invariant Scalable Keypoints).

Feature Representation: Building a dataset with extracted features, feature vector representation by Bag-of-words, vector quantization.

Feature Classification: SVM, KNN, Random forest.

Unit No 5: Computer Vision with Deep Learning [7 Hours]

Image classification: CNN, Attention models, Vision transformation.

Generative Models: GAN.

Object detection: Regions with CNN, Fast R-CNN, Faster R-CNN & Mask R-CNN, SSD, YOLO.

Semantic Segmentation using U-Net, Centroid based object tracking

Text Books / Reference Books

1. Multiple View Geometry in Computer Vision: R. Hartley and A. Zisserman, Cambridge University Press.
2. Computer Vision: Algorithms & Applications, R. Szeleski, Springer. Computer vision: A modern approach: Forsyth and Ponce, Pearson.
3. Richard Szeliski, Computer Vision: Algorithms and Applications, 2010.
4. Simon Prince, Computer Vision: Models, Learning, and Inference, 2012.
5. David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, 2002.
6. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995. ISBN: 9780198538646.
7. Bishop, Christopher M. Pattern Recognition and Machine Learning. Springer, 2006. ISBN 978-0-387-31073-2
8. Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000. ISBN: 9780471056690.
9. Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997. ISBN: 9780070428072.
10. Richard Hartley, Andrew Zisserman, Multiple View Geometry in Computer Vision, 2004.

Semester –VII
Data Engineering

BTAIC703	Data Engineering	PCC11	3L- 0T - 0P	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Basic knowledge of Excel and familiarity with data concepts will be beneficial but not mandatory.

Course Objectives:
To learn data engineering concepts, Advanced Excel, Power BI, Tableau, and basic data analysis for effective data manipulation and visualization.

Course Outcomes:
On completion of the course, students will be able to:

CO1	Understand the importance of data engineering and its workflow in managing and integrating data from various sources.
CO2	Apply advanced data manipulation techniques using Excel functions and tools for efficient data processing.
CO3	Utilize Power BI to connect, transform, and model data from diverse sources into meaningful relationships
CO4	Employ Tableau to prepare and transform data through connections, blending, and calculated fields.
CO5	Integrate and automate data pipelines across tools to streamline data workflows and promote collaboration.

Course Contents:

Unit No 1: Introduction to Data Engineering and Data Analysis Fundamental [7 Hours]
Understanding Data Engineering concepts and importance, Workflow and pipeline, Data sources and data integration.
Basic Concepts of Data Analysis: Data types: Categorical, numerical, ordinal, and time-series data, Data distribution: Measures of central tendency and dispersion, Data visualization: Histograms, box plots, scatter plots, etc., Data preprocessing and cleaning, Exploratory Data Analysis (EDA).

Unit No 2: Advanced Excel for Data Manipulation and Analysis [7 Hours]
Excel Data Manipulation Techniques: Sorting and filtering data, Basic Functions (SUMIF and SUMIFS, COUNTIF and COUNTIFS, AVERAGEIF and AVERAGEIFS, IFERROR, CHOOSE, TEXTJOIN, TRANSPOSE, CONCATENATE, SUBTOTAL, INDIRECT, OFFSET, etc.) Advanced functions (VLOOKUP, INDEX, MATCH, etc.), Text-to-columns and data cleansing, Data validation and conditional formatting.
Excel Data Analysis Tools: PivotTables and PivotCharts, What-If analysis and Scenario Manager, Data tables and Goal Seek, Solver add-in for optimization.

Unit No 3: Power BI for Data Transformation and Visualization [7 Hours]

Introduction to Power BI: Power BI components, Power BI Desktop and Power BI Service, Connecting to data sources.

Data Transformation and Modeling in Power BI: Data loading and shaping using Power Query Editor, Data modeling and relationships, Calculated columns and measures, DAX (Data Analysis Expressions) language fundamentals.

Creating Interactive Reports and Dashboards in Power BI: Visualizations and chart types, formatting and customization options, Drill-through and drill-down capabilities, Filters, slicers, and hierarchies.

Unit No 4: Tableau for Data Preparation and Advanced Visualization [7 Hours]

Introduction to Tableau: Tableau Desktop and Tableau Server, Connecting to various data sources, Understanding Tableau workspace and terminology.

Data Preparation and Transformation in Tableau: Data connections and joins, Data blending and data reshaping. Working with metadata and calculations, Tableau data extracts.

Creating Visualizations and Dashboards in Tableau: Building basic charts and graphs, Interactive filters and parameters, advanced visualization techniques, Dashboard design best practices.

Unit No 5: Data sharing and collaboration and Integration [8 Hours]

Explore more complex data engineering challenges and solutions.

Data Integration: Integrating data from different sources, Automating data pipelines.

Excel Automation and Visual Basic for Applications (VBA): Macro recording and editing, User-defined functions (UDFs), Error handling and debugging.

Power BI Sharing and Collaboration: Publishing and sharing reports, Collaboration features and workspaces, Power BI gateways for on-premises data access.

Sharing and Collaboration in Tableau: Publishing and sharing dashboards, User roles and permissions.

Text Books / Reference Books

1. "Excel Bible" by John Walkenbach (For comprehensive Excel reference)
2. "Power Pivot and Power BI: The Excel User's Guide to DAX, Power Query, Power BI & Power Pivot" by Rob Collie and Avichal Singh (For Power BI and DAX)
3. "Tableau Your Data!: Fast and Easy Visual Analysis with Tableau Software" by Daniel G. Murray (For Tableau)

Semester –VII

Time Series Analysis & Forecasting

BTAIPE704A	**Time Series Analysis & Forecasting**	**PEC-4**	**3L- 1T - 0P**	**4 Credits**

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Basic knowledge of statistics and data analysis concepts. Familiarity with data manipulation and visualization using tools like Python or R.

Course Objectives:
To Gain proficiency in analyzing time-dependent data patterns and using statistical methods to make accurate predictions and forecasts for future trends and events.

Course Outcomes:
On completion of the course, students will be able to:

CO1	Knowledge of basic concepts in time series analysis and forecasting
CO2	Understanding the use of time series models for forecasting and the limitations of the methods.
CO3	Ability to criticize and judge time series regression models.
CO4	Distinguish the ARIMA modelling of stationary and nonstationary time series
CO5	Compare with multivariate times series and other methods of applications

Course Contents:

Unit No 1: Introduction of Time Series Analysis [7 Hours]

Introduction to Time Series and Forecasting -Different types of data-Internal structures of time series- Models for time series analysis-Autocorrelation and Partial autocorrelation.

Examples of Time series Nature and uses of forecasting-Forecasting Process-Data for forecasting – Resources for forecasting.

Unit No 2: Statistics Background For Forecasting [8 Hours]

Graphical Displays -Time Series Plots - Plotting Smoothed Data - Numerical Description of Time Series Data - Use of Data Transformations and Adjustments- General Approach to Time Series Modeling and Forecasting- Evaluating and Monitoring Forecasting Model Performance.

Unit No 3: Time Series Regression Model [7 Hours]

Introduction - Least Squares Estimation in Linear Regression Models - Statistical Inference in Linear Regression- Prediction of New Observations - Model Adequacy Checking -Variable Selection Methods in Regression - Generalized and Weighted Least Squares- Regression Models for General Time Series Data- Exponential Smoothing-First order and Second order.

Unit No 4: Autoregressive Integrated Moving Average (ARIMA) Models [7 Hours]
Autoregressive Moving Average (ARMA) Models - Stationarity and Invertibility of ARMA Models - Checking for Stationarity using Variogram- Detecting Nonstationarity - Autoregressive Integrated Moving Average (ARIMA) Models - Forecasting using ARIMA - Seasonal Data - Seasonal ARIMA Models- Forecasting using Seasonal ARIMA Models Introduction - Finding the "BEST" Model -Example: Internet Users Data- Model Selection Criteria - Impulse Response Function to Study the Differences in Models
- Comparing Impulse Response Functions for Competing Models.

Unit No 5: Multivariate Time Series Models and Forecasting [7 Hours]
Multivariate Time Series Models and Forecasting - Multivariate Stationary Process- Vector ARIMA Models - Vector AR (VAR) Models - Neural Networks and Forecasting -Spectral Analysis - Bayesian Methods in Forecasting.

Text Books

1. Introduction To Time Series Analysis And Forecasting, 2nd Edition, Wiley Series In Probability And Statistics, By Douglas C. Montgomery, Cheryl L. Jen(2015). https://b-ok.cc/book/2542456/2fa941
2. Master Time Series Data Processing, Visualization, And Modeling Using Python Dr. Avishek Pal Dr. Pks Prakash (2017) https://b-ok.cc/book/3413340/2eb247
3. Time Series Analysis And Forecasting By ExampleSørenBisgaardMurat Kulahci Technical University Of Denmark Copyright © 2011 By John Wiley & Sons, Inc. All Rights Reserved. https://b-ok.cc/book/1183901/9be7ed

Reference Books

1. Peter J. Brockwell Richard A. Davis Introduction To Time Series And Forecasting Third Edition.(2016). https://b-ok.cc/book/2802612/149485
2. Multivariate Time Series Analysis and ApplicationsWilliam W.S. Wei Department of Statistical Science Temple University, Philadelphia, PA, SA This edition first published 2019 John Wiley & Sons Ltd. https://b-ok.cc/book/3704316/872fbf
3. Time Series Analysis by James D Hamilton Copyright © 1994 by prince town university press. https://b-ok.cc/book/3685042/275c71

Semester –VII

AI Operations

BTAIPE704B	AI Operations	PEC-4	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites:

1. Fundamental knowledge of programming and data analysis concepts.
2. Familiarity with IT operations and basic understanding of DevOps principles.
3. Some exposure to machine learning concepts and algorithms is beneficial.

Course Objectives:

To acquire a thorough understanding of AI Operations (AIOps) concepts, methodologies, and use cases, gain hands-on experience in implementing AIOps techniques and integrating AIOps with CI/CD pipelines for efficient IT operations and application deployment.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Understand the fundamental principles of AI Operations (AIOps) and its significance in modern IT operations
CO2	Perform exploratory data analysis (EDA) and visualize patterns to gain insights from AIOps data.
CO3	Evaluate industry-standard AIOps frameworks and select suitable approaches for specific IT environments
CO4	Comprehend the principles and benefits of Continuous Integration (CI) and Continuous Deployment (CD) in DevOps practices
CO5	AIOPS Implementation and Best Practices

Course Contents:

Unit No 1: Introduction to AI Operations (AIOps) [7 Hours]

Overview of AIOps: Definition, benefits, and importance in modern IT operations.

Data Sources in AIOps: Collection, preprocessing, and aggregation of data from various IT systems.

AIOps Use Cases: Incident management, anomaly detection, root cause analysis, capacity planning.

Challenges in AIOps Implementation: Addressing data quality, scale, and interpretability.

Unit No 2: AIOps Data Analysis and Machine Learning [8 Hours]

Data Analysis for AIOps: Exploratory data analysis (EDA) and data visualization techniques. Time Series Analysis: Analyzing time-dependent data patterns and trends for predictive insights. Supervised and Unsupervised Machine Learning: Using algorithms for anomaly detection and pattern recognition in AIOps. Model Evaluation and Performance Metrics:

Assessing the effectiveness of AIOps models.

Unit No 3: AIOps Frameworks and Implementation [7 Hours]

AIOps Frameworks: Understanding industry-standard AIOps frameworks and architectures.
AIOps Tools: Hands-on experience with AIOps platforms and tools for real-time monitoring and analysis.
Building AIOps Pipelines: Setting up end-to-end AIOps workflows for different use cases.

Unit No 4: CI/CD Pipeline for DevOps and AIOps [7 Hours]

Introduction to CI/CD Pipeline: Principles, benefits, and its role in the software development lifecycle.
CI/CD Tools: Familiarity with popular CI/CD tools like Jenkins, GitLab CI, or Travis CI.
Implementing CI/CD Pipeline: Building automated testing, staging, and deployment processes.

Unit No 5: AIOPS Implementation and Best Practices [7 Hours]

Setting Up AIOps Pipelines: Building end-to-end AIOps workflows for incident detection and response.
Continuous Deployment in AIOps: Integrating CI/CD pipelines to streamline software deployment.
AIOps Challenges and Best Practices: Addressing scalability, data security, and maintaining interpretability in AI-driven IT operations.

Text Books / Reference Books

1. "AIOps: An Introduction to AI-Based Algorithmic IT Operations" by Dan Kohn, Chris Novak, and Cory Isaacson
2. "AI for IT Operations (AIOps) for Dummies" by Pete Goldin and James Kobielus
3. "Practical Time Series Analysis: Prediction with Statistics and Machine Learning" by Aileen Nielsen
4. "Machine Learning Yearning" by Andrew Ng
5. "Site Reliability Engineering: How Google Runs Production Systems" by Niall Richard Murphy, Betsy Beyer, Chris Jones, and Jennifer Petoff
6. "The Phoenix Project: A Novel about IT, DevOps, and Helping Your Business Win" by Gene Kim, Kevin Behr, and George Spafford

Semester –VII

Autonomous Vehicles

BTAIPE704C	Autonomous Vehicles	PEC-4	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites:

1. Solid foundation in programming (Python preferred) and proficiency in data analysis.
2. Basic understanding of machine learning concepts and algorithms.
3. Familiarity with computer vision and image processing will be advantageous.

Course Objectives:

To Develop expertise in AI techniques for autonomous vehicles, covering perception, decision-making, control, and addressing ethical considerations.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Understand the principles and challenges of autonomous vehicles and the role of AI in self-driving technology
CO2	Implement computer vision and deep learning techniques for object detection and recognition on the road.
CO3	Explore end-to-end learning approaches for autonomous vehicle control
CO4	Apply AI techniques for safe and efficient autonomous driving on highways and long-distance routes
CO5	Evaluate security threats and privacy concerns in autonomous systems to ensure data protection

Course Contents:

Unit No 1: Introduction to Autonomous Vehicles [7 Hours]

Overview of Autonomous Vehicles: Evolution, benefits, and challenges.

Sensing and Perception Technologies: Cameras, LiDAR, Radar, and other sensors used in autonomous vehicles. AI in Autonomous Driving: Role of artificial intelligence and machine learning in self-driving cars. Safety and Regulations: Understanding safety standards and legal considerations for autonomous vehicles.

Unit No 2: AI Techniques for Autonomous Driving [8 Hours]

Path Planning and Decision Making: Using AI algorithms for route planning, obstacle avoidance, and decision-making in dynamic environments.

Perception and Object Detection: Applying computer vision and deep learning for object detection and recognition on the road.

Sensor Fusion: Integrating data from multiple sensors to create a comprehensive environment model. Control Systems: Implementing control algorithms to manage vehicle dynamics and movement.

Unit No 3: Machine Learning for Autonomous Vehicles [7 Hours]

Supervised Learning for Perception: Training models to recognize traffic signs, pedestrians, and other vehicles. Reinforcement Learning for Decision Making: Teaching agents to make driving decisions through reinforcement learning. End-to-End Learning: Exploring end-to-end learning approaches for autonomous vehicle control.

Unit No 4: Autonomy in Challenging Environments [7 Hours]

Urban Driving: Handling complex scenarios like traffic, intersections, and pedestrians in urban environments.

Highway and Long-Distance Driving: Techniques for safe and efficient autonomous driving on highways and long-distance routes.

Adverse Weather Conditions: Addressing challenges posed by rain, snow, and other adverse weather conditions.

Edge Cases and Failures: Preparing for and mitigating edge cases and system failures in autonomous driving.

Unit No 5: Ethical and Societal Considerations [7 Hours]

Ethical Challenges: Discussing ethical dilemmas and decision-making in autonomous vehicles. Security and Privacy: Addressing security threats and privacy concerns in autonomous systems. Social Implications: Examining the impact of autonomous vehicles on society, economy, and urban planning.

Text Books / Reference Books

1. "Autonomous Vehicles: Intelligent Transport Systems and Smart Technologies" by Felipe Jiménez, Sara Rodriguez, and J. Andres Diaz-Pace
2. "Self-Driving: Intelligent Transport Systems, Smart Cities, and Artificial Intelligence" by Dimitrios Tzovaras and Petros Ioannou
3. "Reinforcement Learning for Autonomous Vehicles: A Practical Guide with OpenAI Gym, TensorFlow, and TRFL" by Kaushik Balakrishnan
4. "Hands-On AI for Autonomous Vehicles with Unity: Implement Perception, Control, and Navigation for Autonomous Cars and Simulate them with Unity ML-Agents" by Atsushi Sakai and Manisha Biswas
5. "Autonomous Driving: Technical, Legal and Social Aspects" by Markus Maurer, J. Christian Gerdes, Barbara Lenz, Hermann Winner, and Gereon Meyer

Semester –VII

Full Stack Development

BTAIPE704D	Full Stack Development	PEC-4	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Basic Knowledge of HTML and CSS

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Fundamentals of web essentials and markup languages
2. Use of the Client-side technologies in web development
3. Use of the Server-side technologies in web development
4. Understand the web services and frameworks

Course Outcomes:

On completion of the course, students will be able to:

CO1	Implement and analyze behavior of web pages using HTML and CSS
CO2	Apply the client-side technologies for web development
CO3	Analyze the concepts of Servlet and JSP
CO4	Analyze the Web services and frameworks
CO5	Apply the server side technologies for web development

Course Contents:

Unit No 1: Full Stack Fundamentals [7 Hours]

HTML, Basic, HTML5 Doctype, Some New HTML5 Elements, HTML5 advance feature Canvas Elements, Geolocation API, Responsive Images, Audio and Video Support, Header And Footer, Allow spell check and editable areas, Adding audio, Drag & drop.

CSS Advanced: Advanced Colors: Alpha transparency, At-Rules: Importing style sheets, styles for different media types, specifying the character set of a stylesheet and embedded fonts, CSS3: also known as Cascading Style Sheets Level 3.

Unit No 2: jQuery [8 Hours]

jQuery Introduction, - Overview, Syntax, Selectors, Events, Attributes, jQuery DOM manipulation: - Add Elements, Remove Elements, Replace Elements. jQuery CSS manipulations: CSS Classes, Dimensions, CSS Properties.

Jquery Traversing, Traversing Ancestors, Traversing Descenants.

Unit No 3: Angular JS **[7 Hours]**

Overview, Environment Setup, AngularJS – MVC Architecture, directives, Expressions, controllers, Angular Lifecycle, HTML DOM, Angular Modules, Angular Components, Angular Data Binding, Angular services, Dependency Injection.

Unit No 4: Javascripts Advanced **[7 Hours]**

Arrow Functions, Template Strings, Rest Operator, Spread Operator, Object Literals, Destructuring objects in javascript, inheritance, Getting parts of a value: split & substr, Programming fundamentals: Try...Catch And Throw, Getting the users date and time, Some more complex math, Regular Expressions, Get the users browser (navigator), Add timing: setInterval & setTimeout, Javascript Classes, Async in JavaScript, Error Handling in JavaScript.

Unit No 5: Node JS **[7 Hours]**

Introduction to Node JS, What is Node JS, Node.js Process Model, Node JS Modules: Functions, Buffer, Module, Core Modules, Local Modules, Built-in Modules.

File System, Fs.readFile, Writing a File, Opening a file, deleting a file, Other IO Operations Database operations: Database Connectivity, Connecting String, Configuring, Working with Select Command, Updating Records, Deleting Records, MERN: Overview of MERN, Introduction of MERN.

Text Books / Reference Books

1. Jeffrey C. Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035
2. Robert W Sebesta, “Programming the World Wide Web , 4th Edition, Pearson education, 2008
3. Marty Hall, Larry, “Core Web Programming", Second Edition, Pearson Education, 2001, ISBN 978-0130897930.
4. H.M. Deitel, P.J. Deitel and A.B. Goldberg, "Internet & World Wide Web How To Program", Third Edition, Pearson Education, 2006, ISBN 978-0131752429.
5. Chris Bates, “Web Programming Building Internet Applications , 3rd Edition, Wiley India, 2006.
6. Xue Bai et al, “The web Warrior Guide to Web Programming , Thomson, 2003

Semester –VII

Data Science Optimization Techniques

BTAIOE705A	Data Science Optimization Techniques	OEC-3	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Concept of Data Analysis.

Course Objectives:

1. To familiarize the students with some basic concepts of optimization techniques and approaches.
2. To formulate a real-world problem as a mathematical programming model.
3. To develop the model formulation and applications are used in solving decision problems.
4. To solve specialized linear programming problems like the transportation and assignment Problems.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Apply operations research techniques like linear programming problem in industrial optimization problems.
CO2	Solve allocation problems using various OR methods.
CO3	Understand the characteristics of different types of decision making environment and the appropriate decision making approaches and tools to be used in each type.
CO4	To solve specialized linear programming problems like the transportation and assignment Problems.
CO5	Recognize competitive forces in the marketplace and develop appropriate reactions based on existing constraints and resources.

Course Contents:

Unit No 1: Mathematical Foundations [7 Hours]

Functions and Continuity, Review of Calculus, Vectors, Matrix Algebra, Eigenvalues and Eigenvectors, Optimization and Optimality, General Formulation of Optimization Problems Algorithms, Complexity, and Convexity: What Is an Algorithm?, Order Notations, Convergence Rate, Computational Complexity, Convexity, Stochastic Nature in Algorithms.

Unit No 2: Optimization Algorithms [8 Hours]

Unconstrained Optimization, Gradient-Based Methods, Gradient-Free Nelder–Mead Method Constrained Optimization: Mathematical Formulation, Lagrange Multipliers, Slack Variables, Generalized Reduced Gradient Method, KKT Conditions, Penalty Method Optimization Techniques: Approximation Methods: BFGS Method, Trust-Region Method, Sequential

Quadratic Programming, Convex Optimization, Equality Constrained Optimization, Barrier Functions, Interior-Point Methods, Stochastic and Robust Optimization.

Unit No 3: Linear Programming [7 Hours]

Introduction, Simplex Method, Worked Example by 12 Simplex Method, Interior-Point Method for LP Integer Programming: Integer Linear Programming, LP Relaxation, Branch and Bound, Mixed Integer Programming, Applications of LP, IP, and MIP Regression and Regularization: Sample Mean and Variance, Regression Analysis, Nonlinear Least Squares, Over-fitting and Information Criteria, Regularization and Lasso Method, Logistic Regression, Principal Component Analysis.

Unit No 4: Machine Learning Algorithms [7 Hours]

Data Mining, Data Mining for Big Data, Artificial Neural Networks, Support Vector Machines, Deep Learning Queueing Theory and Simulation: Introduction, Arrival Model, Service Model, Basic Queueing Model, Little's Law, Queue Management and Optimization Multiobjective Optimization: Introduction, Pareto Front and Pareto Optimality, Choice and Challenges, Transformation to Single Objective Optimization, The Constraint Method, Evolutionary Approaches.

Unit No 5: Constraint-Handling Techniques [7 Hours]

Introduction and Overview, Method of Lagrange Multipliers, Barrier Function Method, Penalty Method, Equality Constraints via Tolerance, Feasibility Criteria, Stochastic Ranking, Multi-objective Constraint-Handling and Ranking Evolutionary Algorithms: Evolutionary Computation, Evolutionary Strategy, Genetic Algorithms, Simulated Annealing, Differential Evolution Nature-Inspired Algorithms: Introduction to SI, Ant and Bee Algorithms, Particle Swarm Optimization, Firefly Algorithm, Cuckoo Search, Bat Algorithm, Flower Pollination Algorithm, Other Algorithms.

Text Books / Reference Books

1. Optimization Techniques and Applications with Examples Xin-She Yang Wiley 3 rd 2018
2. Optimization Techniques A.K. Malik, S.K. Yadav, S.R. Yadav I.K. International Publishing House 1 st 2012
3. Optimization methods: from theory to design Marco Cavazzuti Springer 1st 2012
4. Optimization Techniques Chander Mohan, Kusum Deep New Age International 1st 2009

Semester –VII

Blockchain Technology

BTAIOE705B	Blockchain Technology	OEC-3	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Digital Communication.

Course Objectives:

1. To understand the cryptographic techniques used in blockchain systems and to introduce the fundamental concepts and principles of blockchain technology.
2. Understand the fundamentals of Ethereum and DApps and implementation Smart contract.

Course Outcomes:

On completion of the course, students will be able to:

CO1	Explain the fundamental characteristics of blockchain using bitcoin.
CO2	Demonstrate the application of hashing and public key cryptography in protecting the blockchain.
CO3	Explain the elements of trust in a Blockchain: validation, verification, and consensus.
CO4	Develop smart contracts in Ethereum framework.
CO5	Blockchain Usecases

Course Contents:

Unit No 1: Introduction to blockchain [7 Hours]

History of blockchain, peer to peer (P2P) network, public ledger, double spend problem, features of blockchain, types of blockchain: public, private and consortium based blockchain and applications of blockchain.

Unit No 2: Cryptographic primitives [7 Hours]

Public key cryptography, hash functions, message digest, secure hash algorithms (SHAS-256), digital signature, elliptic curve digital signature algorithms (ECDSA), merkle tree.

Unit No 3: Bitcoin definition, transactions [8 Hours]

The transaction life cycle, the structure of a block, genesis block, wallet, bitcoin mining, forking: hard and soft fork. Consensus algorithms: proof of work, proof of stake, practical byzantine fault tolerance, proof of burn and prof of elapsed time.

Unit No 4: Smart contracts, Ethereum basics [7 Hours]

Introduction to Ethereum & Ether, Gas, the world state, transactions, Ethereum virtual machine (EVM), types of accounts, block structure, ether, DApps. Ethereum vs bitcoin.

Unit No 5: Blockchain Use Cases **[7 Hours]**

Land Registry Records, Cross-border payments over blockchain, Project Ubin, Food Security, Supply chain financing, Voting system and Identity on Blockchain, Supply chain management, Healthcare and electronic medical records, Blockchain and Metaverse.

Text Books / Reference Books

1. Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda, A Beginner's Guide to Building Blockchain Solutions, Apress, 2018.
2. Ritesh Modi, Solidity Programming Essentials-A Beginner's Guide to Build Smart Contractsfor Ethereum and Blockchain, 2018, Packt Publishing Ltd.
3. Melanie Swan, Blockchain: Blueprint for a New Economy, O'Reilly, 2015
4. William Stallings, Cryptography and Network Security, eighth edition, Pearson, 2020.
5. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O Dowd, Venkatraman Ramakrishna, Hands-On Block Chain with Hyperledger: Building Decentralized Applicationswith Hyperledger Fabric and Composer , Import, 2018.
6. Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Packt Publishing,2020, ISBN:9781839213199, book website:https://www.packtpub.com/product/mastering-blockchain-third-edition/9781839213199

Semester –VII

Quantum Computing

BTAIOE705C	Quantum Computing	OEC-3	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Nil.

Course Objectives:

1. Design and create quantum circuits for quantum algorithms to run on quantum computers..
2. Analyze quantum information protocols using the basic mathematical structure of quantum mechanics, including states, operations and measurements to validate performance claims..

Course Outcomes:

On completion of the course, students will be able to:

CO1	Basics of complex vector spaces.
CO2	Quantum mechanics as applied in Quantum computing.
CO3	Understand quantum information theory, quantum computation, quantum cryptography and related topics
CO4	Fundamentals of Quantum computations.
CO5	Architecture and algorithms

Course Contents:

Unit No 1: Introduction to Quantum Computation and Present State of Affairs [7 Hours]

Basics of Quantum theory, Mathematical Model of Quantum Computing, Introduction to quantum computers, Linear operators and spectral decomposition. Latest developments in quantum computing – Information only.

Unit No 2: Background Mathematics and Physics [7 Hours]

Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis.

Unit No 3: Quantum Circuits [8 Hours]

Quantum bits, Bloch sphere representation of a qubit, multiple qubits Bits, Classical gates versus quantum gates, single qubit gates, multiple qubit gates, design of quantum circuits, Quantum error correcting codes, Quantum fault tolerance.

Unit No 4: Quantum Information and Cryptography [7 Hours]

Classical Cryptography, RSA algorithm , Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning

theorem. Mathematical models of quantum computation, their relationships to each other, and to physical systems, Quantum Cryptography – BB 84 protocol.

Unit No 5: Quantum Algorithms Classical computation on quantum computers [7 Hours]
Relationship between quantum and classical complexity classes. Deutsch;s algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search. Noise and error correction: Graph states and codes, Quantum error correction, fault-tolerant computation, Quantum algorithms, Simon's algorithm, The prime factorization algorithm.

Text Books / Reference Books

1. Nielsen, Michael A., and Isaac L. Chuang. Quantum Computation and Quantum Information. Cambridge, UK: Cambridge University Press, September 2000. ISBN: 9780521635035.
2. Quantum computing explained, David McMahon, Wiley-interscience, John Wiley & Sons, Inc. Publication 2008
3. Peres, Asher. Quantum Theory: Concepts and Methods. New York, NY: Springer, 1993. ISBN: 9780792325499.
4. Pittenger A. O., An Introduction to Quantum Computing Algorithms
5. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific.

Semester –VII

Mobile Application Development

BTAIOE705D	Mobile Application Development	OEC-3	3L- 1T - 0P	4 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial: 1 hr./week	Continuous Assessment : 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs.)

Pre-Requisites: Data Structures, Object Oriented, Java Programming.

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Overall life cycle of Android programming
2. Essential Components of an Android Application

Course Outcomes:

On completion of the course, students will be able to:

CO1	Understand Android architecture, activities and their life cycle
CO2	Apply the knowledge to design user interface using Android UI and Component
CO3	Describe Memory and File operations in Android
CO4	Manage system database, remote database operations using web services and Firebase
CO5	Apply knowledge of map, location services, Graphics, android system and background services

Course Contents:

Unit No 1: Introduction to Android [7 Hours]

Background about mobile technologies, Android – An Open Platform for Mobile development, Native Android Application, Android SDK Features, Android Architecture, Application Frameworks, Android Libraries, Android Runtime, Dalvik Virtual Machine. Creating First Android Application. Creating Configurations. Android Project Structure. Testing the application (AVD, Active device), Android Manifest file. Running and Debugging.

Unit No 2: User Interface, Activities [7 Hours]

Introduction, Android Application Life Cycle, Activity, Layouts, Application Priority and process states, Fundamental Android UI Design, Study of different layouts, Introducing Views, Creating new Views, Draw able Resources. Designing fragments: Fragments lifecycle, Fragment management and integration. Advanced UI: Adapters, Complex UI components, Menus and Dialogs, Tabbed Activities, Navigation Drawer, Animations, Create activity layouts programmatically. Android Material Design: introduction, properties, Material Styling / Animations, Material Patterns.

Unit No 3: Intents, Broadcast Receivers and Files [8 Hours]

Introducing Intents, Intents and Intent filters, What are Pending Intents, Adapters, Internet Resources, Notifications, Introducing Dialogs, Saving Application Data in external and internal memory, Creating and saving preferences, Retrieving shared preferences, Creating a standard preference activity, Saving Activity State, Saving and Loading Files, Including static files as Resources, File management tools.

Unit No 4: Database and Content Providers [7 Hours]

Introducing Android Databases, Introducing SQLite, Cursors and content values, working with SQLite Database, Creating new content Provider. SQLite Open Helper and creating a database. Opening and closing a database, working with cursors, Inserts, updates, and deletes. Native Content Providers: Content provider types, searching for content, Adding, changing, and removing content, Native Android Content Providers, Accessing Contact Book, Calendar. Custom Content Providers: Custom Content Provider classes, Publishing content providers. Introduction to Firebase, Real time/Cloud, Authentication in firebase.
Connecting to MySQL using JSON (Web services).

Unit No 5: Telephony, Hardware and Network Services [7 Hours]

Telephony, Reading Phone device details, Reading Sims Details, Incoming and outgoing call monitoring, Tracking Service Change, Introducing SMS and MMS, Sending SMS and MMS, Sending SMS messages manually, Use of Bluetooth, Managing Network Connectivity, Managing Wi-Fi. Google Map - Layout file, Google Map – Android Manifest file, Customizing Google Map, Adding Marker, Changing Map Type.

Note: Hands-on practice should be cover under Tutorial slots.

Text Books / Reference Books

1. John Horton, “Android Programming for Beginners”, 2nd Edition Packt Publishing
2. Pradeep Kothari “Android Application Development Black Book” , DreamTech
3. Dawn Griffiths, “Headfirst Android Development”, 1st Edition, O′Reilly
4. Lauren Darcey, “Android Wireless Application Development”, Shane Conder, Pearson
5. Wei Meng Lee “Beginning Android 4 Application Development”, Wrox

Semester –VII

Natural language Processing Lab and Data Engineering Lab

BTAIL707	**Natural language Processing Lab and Data Engineering Lab**	**LC5**	**0L-0T-4P**	**2 Credits**

Teaching Scheme	**Examination Scheme**
Practical: 04 hrs./week	Continuous Assessment 1: 30 Marks Continuous Assessment 2: 30 Marks End Semester Examination: 40 Marks

Natural language Processing Lab

List of Practical/Tutorial

Experiment No.	**Title of the Experiment**
1	Convert the text into tokens. Find the word frequency.
2	Find the synonym /antonym of a word using WordNet.
3	Demonstrate a bigram / trigram language model. Generate regular expression for a given text
4	Perform Lemmatization and Stemming. Identify parts-of Speech using Penn Treebank tag set.
5	Implement HMM for POS tagging. Build a Chunker
6	Implement Named Entity Recognizer.
7	Implement semantic role labelling to identify named entities.
8	Implement text classifier using logistic regression model.
9	Implement a movie reviews sentiment classifier.
10	Implement RNN for sequence labelling.
11	Implement POS tagging using LSTM.
12	Word sense disambiguation by LSTM/GRU.

Note:

1. Open-Source tools and technology use for programs
2. Lab should be in scope of hands of experience and practice related program must
3. Add case study and Live project experience if any related contents.
4. Conduct any 10 practical.

Data Engineering Lab

List of Practical

Excel -

1. To study and demonstrate fundamentals in Microsoft excel.
2. To study and demonstrate Entering and editing text and formulas.

Advanced Excel –

3. To study and demonstrate working with basic excel functions, modifying an excel worksheet.
4. To study and demonstrate data formatting in an excel worksheet.

Power BI –

5. To study and demonstrate introduction to Power BI, basic charts in Power BI, working with maps, Tables and Matrix in Power BI.
6. To study and demonstrate other charts in Power BI, cards and filters, slicers in Power BI, Advanced charts in Power BI.
7. To study and demonstrate objects in Power BI, Power BI service introduction, power query [text, Date functions].
8. To study and demonstrate Number functions, append files, merge files, conditional columns, power query [imp topics, M language introduction].

Tableau –

9. To study and demonstrate Introduction to Tableau, Data in Tableau, Sets, sorting and filtering in Tableau, parameters.
10. To study and demonstrate Groups, folders and hierarchies, marks card, views and highlighting, formatting in Tableau.
11. To study and demonstrate Lines and bands, Tableau worksheets, charts in Tableau part -1, calculated fields.
12. To study and demonstrate charts in Tableau part -2, aggregation and granularity, database functions, box and whisker plot, time series and forecasting.

Note:

1. Open-Source tools and technology use for programs (Advanced Excel, Power BI & Tableau).
2. Lab should be in the scope of hands of experience and practice related programs.
3. Add case study and Live project experience if any related content.
4. Conduct any 10 practical.

Semester –VII

Project

BTAIM708	**PROJECT**	**PROJ**	**0L-0T-4P**	**2 Credits**

Teaching Scheme	**Examination Scheme**
Practical: 024hrs./week	Continuous Assessment : 60 Marks End Semester Examination: 40 Marks

Guidelines for Project

The students shall study in group of max. three members (or individual) on some special topic beyond the scope of the syllabus under the subjects of Artificial Intelligence, Data Science, Cyber security, Computer Vision, Electronics Engineering and Computer Science Engineering or inter discipline branch from current literature, by referring the current technical journal or reference books, under the guidance of the teacher.

In this subject head, it is expected that the student should complete the following tasks.

1. Identify problem statement / idea which is solving one problem preferably localproblem may bein their University / College / nearby vicinity.
2. Do the literature survey,
3. Design the solutions
4. Implement solution using latest technology
5. Write 35-40 pages report and submit with hard binding (use of latex is more suitable).
6. Present / demonstrate the solution in front of faculty member

The students shall prepare his report and execution of project for other students of his class inthe presence of his guide and examiner. The student is permitted to use audio-visual aids or any other such teaching aids.

Continues Assessment:

The Continues Assessment for this head will consists of the report written in a technical reporting manner and execution of project will be assessed by the internal examiner appointed by the HOD of concern department of the institution.

Semester –VIII

Project Work / Internship

BTAIF801	**Project Work/ Internship**	**Project/ Internship**	**0L-0T-24P**	**12 Credits**

Teaching Scheme	**Examination Scheme**
Practical: 24 hrs./week	Continuous Assessment : 60 Marks End Semester Exam: 40 Marks Total : 100 Marks

Guidelines for Project

It is recommended to complete industry or industry sponsored project. The students shall study in group of max. three members (or individual) on some special topic beyond the scope of the syllabus under the subjects of Artificial Intelligence, Data Science, Machine learning or inter discipline branch from current literature, by referring the current technical journal or reference books, under the guidance of the teacher.

In this subject head, it is expected that the student should complete the following tasks.

1. Identify problem statement / idea which is solving one problem preferably local problem may being their University / College / nearby vicinity.
2. Do the literature survey,
3. Design the solutions,
4. Implement solution using latest technology,
5. Write 60-70 pages report and submit with hard binding (use of latex is more suitable),
6. Present / demonstrate the solution in front of faculty member.

The students shall prepare his report and execution of project for other students of his class inthe presence of his guide and examiner. The student is permitted to use audio-visual aids or any other such teaching aids.

Continues Assessment:

The Continues Assessment for this head will consists of the report written in a technical reporting manner and execution of project will be assessed by the internal examiner appointed by the HOD of concern department of the institution.

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

COURSE CURRICULUM MAPPING WITH MOOC PLATFORM NPTEL

Sr. No	Course Title	Course Code	Semester	SWAYAM/ NPTEL Course And Web Link	Name of Institute offering	Relevance	Duration
1	Natural Language Processing	BTAIC701	VII	**NPTEL:** https://onlinecourses.nptel.ac.in/noc23_cs45/preview	IIT Kharagpur	85%	12 Week
2	Advanced Computer Vision	BTAIC702	VII	**NPTEL:** https://onlinecourses.nptel.ac.in/noc19_cs58/preview	IIT Kharagpur	75%	12 Week
3	Data Engineering	BTAIC703	VII	**NPTEL:** https://onlinecourses.nptel.ac.in/noc21_cs69/preview	IIT Madras	85%	8 Week
4	**Professional Elective Course (PEC)-BTAIPE704**						
	1. Time Series Forecasting	BTAIPE704A	VII	**NPTEL** https://onlinecourses.nptel.ac.in/noc21_ch28/preview	IIT Madras	65%	12 Week
	2. AI Operations	BTAIPE704B	VII	**NPTEL:** https://onlinecourses.nptel.ac.in/noc22_cs56/preview	IIT Delhi	75%	12 Week
	3. Autonomous Vehicle	BTAIPE704C	VII	**NPTEL:** https://nptel.ac.in/courses/108106170	IIT Madras	65%	8 Week
	4. Full Stack Development	BTAIPE704D	VII	-	-	-	-
5	**Open Elective Course (OEC) – BTAIOE705**						
	1.Data Science Optimization Techniques	BTAIOE705A	VII	**NPTEL:** https://nptel.ac.in/courses/106106245	IIIT Delhi	85%	8 Week
	2. Block chain Technology	BTAIOE705B	VII	**NPTEL:** https://onlinecourses.nptel.ac.in/noc20_cs01/preview **Coursera:** https://www.coursera.org/specializations/blockchain	IIT Kanpur	85%	8 Week
	3. Quantum Computing	BTAIOE705C	VII	**NPTEL:** https://onlinecourses.nptel.ac.in/noc19_cy31/preview **Coursera:** https://www.coursera.org/learn/introduction-to-quantum-information	IIT Kanpur	80%	12 Week
	4. Mobile Application Development	BTAIOE705D	VII	**NPTEL:** https://archive.nptel.ac.in/courses/106/106/106106156/	IIT Madras	75%	8 Week
6	**Humanities and Social Sciences including Management Elective Course (HSSMEC) :BTAIHM706**						
	1. Foreign Language Studies	BTAIOE706A	VII	**NPTEL (German):** https://nptel.ac.in/courses/109106166	IIT Madras	45%	12 Week
				NPTEL (Japanese) https://nptel.ac.in/courses/121104005	IIT Kanpur	45%	12 Week
	2. Universal Human Value & Ethics	BTAIOE706B	VII	**NPTEL:** https://nptel.ac.in/courses/109104068	IIT Kanpur	65%	12 Week
	3. Intellectual Property Rights	BTAIOE706C	VII	**NPTEL:** https://onlinecourses.nptel.ac.in/noc22_hs59/preview	IIT Madras	75%	12 Week

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

COURSE CURRICULUM MAPPING WITH MOOC PLATFORM COURSERA

Sr. No	Course Title	Course Code	Semester	SWAYAM/ NPTEL Course And Web Link	Name of Institute offering	Relevance	Duration
1	Natural Language Processing	BTAIC701	VII	https://shorturl.at/hmIWZ	DeepLearning.AI	50%	3 Month
2	Advanced Computer Vision	BTAIC702	VII	https://shorturl.at/biBJ6	DeepLearning.AI	60%	19 week
3	Data Engineering	BTAIC703	VII	https://www.coursera.org/learn/introduction-to-data-engineering	IBM		4 Week
4	**Professional Elective Course (PEC)-BTAIPE704**						
	1. Time Series Forecasting	BTAIPE704A	VII	https://www.coursera.org/learn/tensorflow-sequences-time-series-and-prediction	DeepLearning.AI	50%	4 week
	2. AI Operations	BTAIPE704B	VII	https://www.coursera.org/learn/introduction-to-ai	IBM	60%	4 week
	3. Autonomous Vehicle	BTAIPE704C	VII	-	-	-	-
	4. Full Stack Development	BTAIPE704D	VII	https://www.coursera.org/professional-certificates/ibm-full-stack-cloud-developer	IBM	85%	3-6 Month
5	**Open Elective Course (OEC) – BTAIOE705**						
	1.Data Science Optimization Techniques	BTAIOE705A	VII	-	-	-	-
	2. Block chain Technology	BTAIOE705B	VII	**Coursera:** https://www.coursera.org/specializations/blockchain	University of Buffalo	65%	2 Months
	3. Quantum Computing	BTAIOE705C	VII	**Coursera:** https://www.coursera.org/learn/introduction-to-quantum-information	KAIST	60%	10 Hrs
	4. Mobile Application Development	BTAIOE705D	VII	https://www.coursera.org/learn/introduction-to-android-mobile-application-development	Meta	75%	4 Week
6	**Humanities and Social Sciences including Management Elective Course (HSSMEC) :BTAIHM706**						
	1. Foreign Language Studies	BTAIOE706A	VII	-	-	-	-
				-	-	-	-
	2. Universal Human Value & Ethics	BTAIOE706B	VII	https://www.coursera.org/learn/ethical-use-of-technology	The University of NOTRE DAME		4 week
	3. Intellectual Property Rights	BTAIOE706C	VII	https://www.coursera.org/specializations/introduction-intellectual-property	Penn University	80%	1 month 10 hrs

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Sr. No	Course Title	Course Code	Semester	SWAYAM/ NPTEL Course And Web Link	Name of Institute offering	Relevance	Duration
1	Natural Language Processing	BTAIC701	VII	https://shorturl.at/ekxDP	**University of Canterbury**	60%	6 Week
2	Advanced Computer Vision	BTAIC702	VII	https://shorturl.at/jkMZ1	IBM	50%	3 week
3	Data Engineering	BTAIC703	VII	https://www.edx.org/professional-certificate/ibm-data-engineering	IBM	50%	2 Month
4	**Professional Elective Course (PEC)-BTAIPE704**						
	1. Time Series Forecasting	BTAIPE704A	VII	-	-	-	-
	2. AI Operations	BTAIPE704B	VII	-	-	-	-
	3. Autonomous Vehicle	BTAIPE704C	VII	-	-	-	-
	4. Full Stack Development	BTAIPE704D	VII	-	-	-	-
5	**Open Elective Course (OEC) – BTAIOE705**						
	1.Data Science Optimization Techniques	BTAIOE705A	VII	-	-	-	-
	2. Block chain Technology	BTAIOE705B	VII	-	-	-	-
	3. Quantum Computing	BTAIOE705C	VII	https://www.edx.org/course/quantum-computing	University of Chicago	60%	5 week
	4. Mobile Application Development	BTAIOE705D	VII	-	-	-	-
6	**Humanities and Social Sciences including Management Elective Course (HSSMEC) :BTAIHM706**						
	1. Foreign Language Studies	BTAIOE706A	VII	-	-	-	-
				-	-	-	-
	2. Universal Human Value & Ethics	BTAIOE706B	VII	-	-	-	-
	3. Intellectual Property Rights	BTAIOE706C	VII	https://www.edx.org/course/intellectual-property-rights-a-management-perspect	IIM Bangalore	80%	6 week