



**JOY UNIVERSITY**

Established vide Tamil Nadu State Pvt. Universities Act 2019



## **SCHOOL OF COMPUTATIONAL INTELLIGENCE**

*Outcome Based Curriculum Framework with CBCS*

*for*

***BACHELOR OF TECHNOLOGY – COMPUTER  
SCIENCE AND ENGINEERING (ARTIFICIAL  
INTELLIGENCE AND ROBOTICS)***

***(B.Tech. CSE – AI & RO)***

***Students admitted from 2025 -26 onwards***

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## **VISION**

♣ To create and nurture a multidisciplinary global university with highest academics, research and ethical standards in a creative and innovative environment.

## **MISSION**

♣ To be a premier University of choice for all stakeholders and contribute for academic demographic dividend. To inculcate quality, integrity, team work, compassion, ethics in new generation students for catering to various needs of society.

## **QUALITY OBJECTIVES**

- To disseminate knowledge with skills through teaching, training, seminars, workshops, conferences and symposia in Engineering and Technology, Art and Design, Management and Commerce, Allied Health Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences, Law and Agricultural Sciences to enable students to meet the current needs and trends of industries, business and society.
- To provide technical and scientific solutions to real time problems posed by industries, business and society in all Schools of Joy University.
- To inculcate quality, integrity, team work, compassion, ethics in new generation students for catering to various needs of society.
- To promote the spirit of entrepreneurship in the young generation to help and create more career opportunities in the society by incubating a nurturing technology product idea backed by Technology Business Incubation.
- To identify and nurture leadership and innovate skills in students to become future leaders to enrich society.
- To develop collaborations and partnerships with International global and reputed Universities, research establishments, Government and NGO's, industries and businesses. To support both faculties and students for international exposure.

## SCHOOL OF COMPUTATIONAL INTELLIGENCE

### VISION

The SOCI envisions a 'cooperatively competitive' academic environment in the thematic areas of the school and relevant research backed by quality education to churn out graduates with professional acumen, exceptional leadership and a humane heart to meet both national and global needs.

### MISSION

The SOCI offers a value-based, technology-oriented education striving to achieve high levels of academic excellence, intellectually competence and exemplary values. The tri-value system of our school is designed to deliver education through three interconnected values: **Learning, Transmutation and Transformation.**

### PROGRAMME EDUCATIONAL OBJECTIVES

**PEO 1:** Graduates will have the ability and attitude to acquire new skills and adapt recent technological changes.

**PEO 2:** To prepare the graduates to serve in the industries related to Computer Science and Engineering or to do higher education and research.

**PEO 3:** Graduates will work with professionalism and ethics by contributing to the advancement of the society.

### GRADUATE ATTRIBUTES

*The Graduate Attributes of B.Tech CSE (AI & RO) are:*

*GA 1 Apply appropriate knowledge in Computer Science and Engineering to identify, formulate, analyze, and solve complex engineering problems in order to reach substantive conclusions.*

*GA 2 Self-learn and engage in use of advanced computing tools.*

*GA 3 Develop sustainable computing solutions in broader economic, societal and environmental contexts*

*GA 4 Think critically, creatively and analytically as a computer scientist, whilst being able to work effectively, independently and collaboratively as part of a team in research, technology development and entrepreneurial ventures.*

*GA 5 Apply evolving ethics and privacy laws across various domains and territories.*

*GA 6 Effectively communicate engineering concepts and ideas to peers in written or oral forms*

*GA 7 Be motivated to engage in independent and life-long learning in the broadest context of evolving technological challenges*

## PROGRAMME OUTCOMES

On completion of the **B.Tech CSE (Artificial Intelligence & RO) Programme**, students should be able to:

**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 analyse 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 modelling 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

**PSO 1:** Understanding of ethical considerations and societal impacts related to AI/Robotics systems, ensuring responsible and fair use of technology.

**PSO 2:** Proficiency in handling, cleaning, and preprocessing large datasets to extract meaningful insights and improve model predictions.

**PSO 3:** Ability to design, implement, and evaluate robots for real-world applications, optimizing performance and accuracy.

### Summary of Credits

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	20	21	21	20	24	20	20	21	167
Contact Hrs./Week	24	24	24	22	26	24	17	06	167

### SEMESTER WISE CREDIT STRUCTURE

Sl. No.	Category of Courses	1 <sup>st</sup> Year		2 <sup>nd</sup> Year		3 <sup>rd</sup> Year		4 <sup>th</sup> Year		Total
		Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Sem VII	Sem VIII	
1.	Departmental Core	08	07	20	11	12	11	07	–	76
2.	Discipline Specific Electives (DSE)	–	–	–	06	06	06	06	06	30
3.	Open Electives	–	–	–	–	03	03	03	–	09
4.	Applied Sciences	08	11	–	–	–	–	–	–	19
5.	Internships/ Field Visits	–	–	–	–	–	–	02	–	02
6.	Project	–	–	–	–	–	–	02	15	17
7.	Skill Enhancement Course	–	01	–	03	03	–	–	–	07
8.	Ability Enhancement Courses (AECC)	03	–	–	–	–	–	–	–	03
9.	Value-Added Course	01	02	01	–	–	–	–	–	04
<b>Total</b>		<b>20</b>	<b>21</b>	<b>21</b>	<b>20</b>	<b>24</b>	<b>20</b>	<b>20</b>	<b>21</b>	<b>167</b>

**School of Computational Intelligence**  
**B.Tech CSE (Artificial Intelligence & RO)**  
**Semester – I**  
**(Total Credits: 20)**

Sl.No	Course Code	Course Title	L	T	P	Contact Hrs / Wk	Credits
1.	25BTAR111	<b>Core Course</b> Fundamentals of Computing	3	0	0	3	3
2.	25BTAR112	<b>Core Course</b> Introduction to Programming	3	0	0	3	3
3.	25BTAR113	<b>Applied Science</b> Mathematics – I	3	1	0	4	4
4.	25BTAR114	<b>Applied Science</b> Physics I	3	1	0	4	4
5.	25BTAR211	<b>Core Course</b> Fundamentals of Computing Lab	0	0	2	2	1
6.	25BTAR212	<b>Core Course</b> Introduction to Programming Lab	0	0	2	2	1
7.	25AEEN911	<b>Ability Enhancement Compulsory Course (AECC)</b> Effective Communication	3	0	0	3	3
8.	25BTAR911	<b>Value-Added Course</b> Performing Arts/Sports	3	0	0	3	1
		<b>Total</b>	<b>18</b>	<b>2</b>	<b>4</b>	<b>24</b>	<b>20</b>

**Semester – II****(Total Credits: 21)**

<b>SI.No</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Contact Hrs / Wk</b>	<b>Credits</b>
1.	25BTAR121	<b>Core Course</b> Python Programming	3	0	0	3	3
2.	25BTAR122	<b>Applied Science</b> Probability, Statistics and Stochastic Processes	3	0	0	3	3
3.	25BTAR123	<b>Applied Science</b> Mathematics II	3	1	0	4	4
4.	25BTAR124	<b>Applied Science</b> Physics II	3	0	0	3	3
5	25BTAR125	<b>Core Course</b> Discrete Structures for Computer Science	3	0	0	3	3
6	25BTAR221	<b>Core Course</b> Python Programming Lab	0	0	2	2	1
7	25BTAR222	<b>Applied Science</b> Physics Lab	0	0	2	2	1
8	25BTAR223	<b>Skill Enhancement Course</b> Extended Reality and its Applications Lab	0	0	2	2	1
9	25EVST921	<b>Value Added Course</b> Environmental Science	2	0	0	2	2
		<b>TOTAL</b>	<b>17</b>	<b>1</b>	<b>6</b>	<b>24</b>	<b>21</b>

**Semester – III****(Total Credits: 21)**

<b>Sl.No</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Contact Hrs / Wk</b>	<b>Credits</b>
1.	25BTAR131	<b>Core Course</b> Artificial Intelligence	3	0	0	3	3
2.	25BTAR132	<b>Core Course</b> Signals and Systems	3	0	0	3	3
3.	25BTAR133	<b>Core Course</b> Digital Design	3	0	0	3	3
4.	25BTAR134	<b>Core Course</b> Data Structures and Algorithms	3	0	0	3	3
5.	25BTAR135	<b>Core Course</b> Object-Oriented Programming with Java	3	0	0	3	3
6.	25BTAR136	<b>Core Course</b> Professional Ethics	2	0	0	2	2
7.	25BTAR231	<b>Core Course</b> Digital Design Lab	0	0	2	2	1
8.	25BTAR232	<b>Core Course</b> Data Structures and Algorithms Lab	0	0	2	2	1
9.	25BTAR233	<b>Core Course</b> Object-Oriented Programming with Java Lab	0	0	2	2	1
10.	25BTAR931	<b>Value Added Course</b> Indian Constitution	1	0	0	1	1
		<b>Total</b>	<b>18</b>	<b>0</b>	<b>06</b>	<b>24</b>	<b>21</b>

**Semester – IV**

**(Total Credits: 20)**

<b>Sl.No</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Contact Hrs / Wk</b>	<b>Credits</b>
1.	25BTAR141	<b>Core Course</b> <b>Robotics</b>	3	0	0	3	3
2.	25BTAR142	<b>Core Course</b> Database Management Systems	3	0	0	3	3
3.	25BTAR143	<b>Core Course</b> Computer Organization and Architecture	3	0	0	3	3
4.	25BTAR341	<b>Programme Specific Elective (PSE) I</b> Operating Systems	3	0	0	3	3
	25BTAR342	Data Mining and Data Warehousing					
	25BTAR343	Social Network Analysis					
5.	25BTAR344	<b>Programme Specific Elective (PSE) II</b> Full Stack Development	3	0	0	3	3
	25BTAR345	Edge AI					
	25BTAR346	Design and Analysis of Algorithms					
6	25BTAR841	<b>Skill Enhancement Course</b> Engineering Economics and Foreign Trade	3	0	0	3	3
7	25BTAR241	<b>Core Course</b> <b>Robotics Lab</b>	0	0	2	2	1
8	25BTAR242	<b>Core Course</b> Database Management Systems Lab	0	0	2	2	1
		<b>Total</b>	<b>18</b>	<b>0</b>	<b>04</b>	<b>22</b>	<b>20</b>

**Semester – V**

**(Total Credits: 24)**

Sl.No	Course Code	Course Title	L	T	P	Contact Hrs / Wk	Credits
1.	25BTAR151	<b>Core Course</b> Sensors and Actuators for Robotic	3	0	0	3	3
2.	25BTAR152	<b>Core Course</b> Robot Design	3	0	0	3	3
3.	25BTAR153	<b>Core Course</b> Theory of Computation	3	1	0	4	4
4.	25BTAR351 25BTAR352 25BTAR353	<b>Programme Specific Elective (PSE) III</b> Software Engineering Nature Inspired Computing Fuzzy sets, Logics and Systems	3	0	0	3	3
5.	25BTAR354 25BTAR355 25BTAR356	<b>Programme Specific Elective (PSE) IV</b> Quantum Machine Learning Cognitive Computing Natural Language Processing	3	0	0	3	3
6	25BTAR851	<b>Skill Enhancement Course</b> Principles of Management	3	0	0	3	3
7	25BTAR251	<b>Core Course</b> Sensors and Actuators for Robotics Lab	0	0	2	2	1
8	25BTAR252	<b>Core Course</b> Robot Design Lab	0	0	2	2	1
9	25BTAR051 25BTAR052 25BTAR053	<b>Open Elective I (Generic)</b> Artificial Intelligence Python Programming Computer Networks	3	0	0	3	3
		<b>Total</b>	<b>21</b>	<b>01</b>	<b>04</b>	<b>26</b>	<b>24</b>

**Semester – VI**

**(Total Credits: 20)**

SI.No	Course Code	Course Title	L	T	P	Contact Hrs / Wk	Credits
1.	25BTAR161	<b>Core Course</b> Robot Programming	3	0	0	3	3
2.	25BTAR162	<b>Core Course</b> Compiler Design	3	0	0	3	3
3.	25BTAR163	<b>Core Course</b> Industrial Electronics and Power Convertors	3	0	0	3	3
4.	25BTAR361 25BTAR362 25BTAR363	<b>Programme Specific Elective (PSE) V</b> Applied Artificial Intelligence Neuromorphic Computing Computer Vision	3	0	0	3	3
5.	25BTAR364 25BTAR365 25BTAR366	<b>Programme Specific Elective (PSE) VI</b> Robot Control Systems Internet of Things Game Theory for Robotics	3	0	0	3	3
6.	25BTAR261	<b>Core Course</b> Robot programming Lab	0	0	2	2	1
7.	25BTAR262	<b>Core Course</b> Compiler Design Lab	0	0	2	2	1
8.	25BTAR061 25BTAR062 25BTAR063	<b>Open Elective II (Generic)</b> AI Tools Internet of Things Cybersecurity	3	0	0	3	3
		<b>Total</b>	<b>18</b>	<b>0</b>	<b>04</b>	<b>22</b>	<b>20</b>

**Semester – VII**

**(Total Credits: 20)**

Sl.No	Course Code	Course Title	L	T	P	Contact Hrs / Wk	Credits
1.	25BTAR171	<b>Core Course</b> Robot Dynamics and Trajectory Planning	3	0	0	3	3
2.	25BTAR172	<b>Core Course</b> Ethics, Policy, Laws and Standards in AI	3	0	0	3	3
3.	25BTAR371 25BTAR372 25BTAR373	<b>Programme Specific Elective (PSE) VII</b> Internet of Robotic Things (RIoT) Bionics Micro Electro Mechanical Systems	3	0	0	3	3
4.	25BTAR374 25BTAR375 25BTAR376	<b>Programme Specific Elective (PSE) VIII</b> Pattern Recognition Computational and Systems Biology Digital Marketing	3	0	0	3	3
5	25BTAR271	<b>Core Course</b> Robot Dynamics and Trajectory Planning Lab	0	0	2	2	1
6	25BTAR471	Industrial Internship	0	0	0	0	2
7	25BTAR571	Mini Project	0	0	0	0	2
8	25BTAR071 25BTAR072 25BTAR073	<b>Open Elective III</b> Advanced Python Programming Optimization Algorithms Computing (Latest)	3	0	0	3	3
		<b>Total</b>	<b>15</b>	<b>0</b>	<b>02</b>	<b>17</b>	<b>20</b>

**Semester – VIII**

**(Total Credits: 21)**

<b>Sl.No</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Contact Hrs / Wk</b>	<b>Credits</b>
1.	25BTAR581	Capstone Project	0	0	0	0	15
2.	25BTAR381	<b>Programme Specific Elective (PSE) IX</b> Mobile, Micro and Nano Robotics	3	0	0	3	3
	25BTAR382	Intelligent Manufacturing					
	25BTAR383	GPU Computing					
3.	25BTAR384	<b>Programme Specific Elective (PSE) X</b> Special Intelligent Machine	3	0	0	3	3
	25BTAR385	Web Data Mining					
	25BTAR386	Generative AI					
		<b>Total</b>	<b>06</b>	<b>0</b>	<b>0</b>	<b>06</b>	<b>21</b>

# **Semester I**

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR 111</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>I</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>FUNDAMENTALS OF COMPUTING</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours</b>	<b>T-Tutorial Hours</b>	<b>P-Practical Hours</b>				
<b>COURSE OBJECTIVES:</b>						
The main learning objective of this course is to prepare the students for:						
<ul style="list-style-type: none"> <li>• To have a comprehensive understanding of a foundational understanding of computer systems.</li> <li>• To learn about various number systems including decimal, binary, octal, and hexadecimal</li> <li>• To develop a comprehensive grasp of how computers function, the types of software used and the significance of networking in today's digital world.</li> <li>• To explore various types of software applications including operating systems, word processors, database management systems and Internet</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to Computer</b> Evolution of Computers, Generations of Computers, Classification of Computers, The Computer System, Computing Concepts, Applications of Computers. <b>Memory and storage systems</b> Computer Software and Hardware components and its requirements- Storage Devices, <b>Computer Viruses</b> Types Of Viruses – Spreading of Virus, Prevention of Computer Virus, Virus Detection, Computer Security, Maintenance, Desktop functions, Dialog boxes, Single Document Interface (SDI), Multiple Document Interface (MDI), Windows Controls, Main Menu Display, Categories of Menus, Main and Context Sensitive Menus, Booting/Shutting Down.				<b>9</b>	
<b>II</b>	<b>Microsoft software</b> MS DOS, MS Word System, MS Excel System, MS Power point System, MS Access System, MS Publisher. <b>Number System</b> Decimal Number System, Binary Number System, Octal Number System, Hexadecimal Number System, BCD, XS,3, Gray Code, Alphanumeric Codes,(ASCII, EBCDIC).				<b>9</b>	
<b>III</b>	<b>Computer Software</b> Machine language, Mnemonics, High level Language, Assembler, Compiler, Interpreter, System Development Programs, SystemManagement Programs , Standard Application Programs , Unique Application Programs, Problem Solving, Structuring the Logic				<b>9</b>	

<b>IV</b>	<b>Memory management</b> Introduction, History, Functions, Process, Memory File, Management Device, Security Management, Types of Operating Systems, Providing User Interface, Popular Operating Systems.	<b>9</b>
<b>V</b>	<b>THE INTERNET AND WORLD WIDE WEB</b> History of the Internet-The Internet Applications-Understanding World Wide Web-Web Browsers-Browsing the Internet-Using a Search Engine-Email Service-Protocols used in the Internet. <b>DATA COMMUNICATIONS AND NETWORKS</b> Introduction-Data Communication Using Modem-Computer Networks-Network Topologies-Network Protocols and Software-Applications of Network.	<b>9</b>

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Understand the basic concepts of computers.

**CO2:** Analyze the basics of number systems.

**CO3:** Apply system development programs to create and manage simple software projects.

**CO4:** Analyze the performance of different memory management techniques and their impact on system efficiency.

**CO5:** Evaluate the knowledge of Internet history to understand current Internet technologies and to solve problems in communication and information access.

### **Text Books:**

1. Fundamentals of Computers, E. Balagurusamy, Tata McGraw Hill Education Private Limited, 2009.

### **Reference Books:**

1. Introduction to Computer Fundamentals, Bright Siaw Afriyie, Second edition, Trafford Publishing, Canada, 2003-2006.
2. Computer Fundamentals, P. K. Sinha, BPB Publications, Sixth Edition, 2004.
3. Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Wiley publishers, Ninth edition, 2013.
4. Computer Networks, Andrew S. Tanenbaum, David J. Wetherall, Fifth edition, Prentice Hall, 2011.
5. Computing Fundamentals: Introduction to Computers, Faithe Wempen, Wiley 2014.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	0	1	1	0	0	0	2	0	0	0	1	3	2	0	0
<b>CO2</b>	3	3	0	2	3	0	0	0	0	0	1	3	2	0	0
<b>CO3</b>	3	3	3	2	2	0	0	0	0	0	3	3	2	1	1
<b>CO4</b>	2	3	1	3	2	0	0	0	0	0	1	3	2	1	1
<b>CO5</b>	3	3	2	3	3	0	0	0	0	0	1	3	2	1	1

3 – High, 2 – Average, 1 – Low, 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR211</b>	<b>Number of Hours/Week</b>	<b>2</b>			
<b>Semester</b>	<b>I</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>1</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>FUNDAMENTALS OF COMPUTING LAB</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>0</b>	<b>0</b>	<b>2</b>	
<b>L-Lecture Hours</b>	<b>T-Tutorial Hours</b>	<b>P-Practical Hours</b>				
<b>LIST OF PROGRAMS</b>						
<ol style="list-style-type: none"> <li>1. Basics of Microsoft Word.</li> <li>2. Insert Table and Generating Chart.</li> <li>3. Mail Merging.</li> <li>4. Study on features of Microsoft Excel.</li> <li>5. Incorporating the predefined functions in Excel.</li> <li>6. Inserting table and generating chart in Excel.</li> <li>7. Pivot chart, table and slicing in Excel.</li> <li>8. Study on features in Microsoft PowerPoint.</li> <li>9. Creating presentation incorporating the features of PowerPoint.</li> <li>10. Study on HTML.</li> <li>11. Basic web page design, formatting, inclusion of image and video.</li> <li>12. Creation of Table.</li> <li>13. Designing own web page.</li> </ol>						

On successful completion of this course, the student will be able to

- CO1:** Understand the basic functionalities of Microsoft Word
- CO2:** Apply advanced Excel features for data management.
- CO3:** Create complex data presentations using Excel pivot tables, charts, and slicers.
- CO4:** Develop professional presentations using advanced PowerPoint features.
- CO5:** Design and develop basic web pages using HTML

### Mapping of Course Outcomes (CO's) with PO's & PSO's

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>0</b>	<b>0</b>
<b>CO2</b>	<b>3</b>	<b>3</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>0</b>	<b>0</b>
<b>CO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>
<b>CO4</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>
<b>CO5</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR112</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>I</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>INTRODUCTION TO PROGRAMMING</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>COURSE OBJECTIVES:</b>						
The main aim of this course is to prepare the students for:						
<ul style="list-style-type: none"> <li>• To learn the fundamental concepts of programming, including algorithms, flowcharts, and the logical approach to problem solving that is applicable to any programming language.</li> <li>• To acquire comprehensive understanding of the syntax, semantics and the basic constructs of C language</li> <li>• Learn to use of pointers, Arrays, and dynamic memory allocation which are key to understanding data structure, memory management .</li> <li>• Build a foundation for advanced programming and software development. To develop skills to handle complex programming challenges such as file handling, Debugging.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to programming</b> Algorithm, Formalism, Flow chart, Assembly language, Introduction to program, Program components, structure, Execution path, Programming paradigms introduction, Syntax and Semantics				<b>9</b>	
<b>II</b>	<b>Introduction to C language</b> History of C, Prerequisites of C, Features and its applications, Structure of C, Preprocessor directives, Data types and constants, variables and its types, Tokens, Identifiers and format specifiers, Operators and Enums, Data I/O, Decision making and Branching, Loop Introduction, programs with looping structure, ControlFlow programs with control flow				<b>9</b>	
<b>III</b>	<b>Array and Strings</b> Introduction to Array, Initialization, Single dimensional array, Multidimensional array, String, Functions with string: Read, Display string and string functions, String Arrays.				<b>9</b>	
<b>IV</b>	<b>Functions and Pointers</b> Function Introduction, Function calling, Return type, Function types, Recursion, Types of Recursion, Introduction to Pointers, Types Pointers, Programming exercises with pointers.				<b>9</b>	
<b>V</b>	<b>Structures and Unions</b> Introduction to structure and simple program using structure concepts, Introduction to Union and programs with union, Storage Classes- Introduction to DMA, Introduction to Pre-processor				<b>9</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1 :** Acquiring foundational knowledge of programming including Algorithm, Flowcharts, assembly language basics, Program structure.

**CO2 :** Understanding C language fundamentals

**CO3 :** Applying various types of arrays and string manipulation technique to manage and process data in programming scenarios

**CO4 :** Analyze and experiment with functions, develop recursive solutions, and apply pointers to solve complex problems.

**CO5 :** Develop modular programs using control structures, unions

## **Text Book**

1. Introduction to Programming Languages 1st Edition by Arvind Kumar Bansal, CRC Press, Taylor and Francis group, 2014.
2. C Programming Language by Brian Kernighan and Dennis Ritchie, Prentice Hall Software, 1988.
3. Programming with C 2nd Edition Byron Gottfried Schaum's outlines, Tata McGraw-Hill publishers, 1998.

## **Reference Books**

1. E. Balagurusamy, 'Programming in ANSI C', 3<sup>rd</sup> edition, Tata McGraw-Hill Publishers, 2004.
2. Eric C.R. Hehner, 'The Logic of Programming', Prentice hall of India, 1991.
3. C: Herbert Schildt, 'The Complete Reference', McGraw Hill, 4<sup>th</sup> edition, 2017

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>CO2</b>	<b>3</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>0</b>
<b>CO3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>0</b>	<b>1</b>	<b>1</b>
<b>CO4</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>1</b>
<b>CO5</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>0</b>	<b>1</b>

3 – High, 2 – Average, 1 – Low, 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>
<b>Course Code</b>	<b>25BTAR212</b>	<b>Number of Hours/Week</b>	<b>2</b>
<b>Semester</b>	<b>I</b>	<b>Max. Marks</b>	<b>100</b>
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>1</b>
<b>INTRODUCTION TO PROGRAMMING LAB</b>			
	<b>L</b>	<b>T</b>	<b>P</b>
	<b>0</b>	<b>0</b>	<b>2</b>

### LIST OF PROGRAMS

1. Write a C program to print Integer, Float, Character values
2. a) Write a C program to demonstrate use of arithmetic operators
2. b) Write a C program using increment and decrement operators
3. a) Write a C program using Decision making constructs (Switch case statement)
3. b) Program to find if a number is Negative, Positive, or zero (using if..elseif..else statement)
4. C program to perform factorial of a number
5. a) Write a C program to print a message 5 times using "while" statement
5. b) Illustrate the Do-while statement using C program
5. c) Program using for loop statement
6. a) Program to implement break statement
6. b) write a program to demonstrate continue statement
7. Program to insert elements into an array and display the array elements using C language
8. Program to solve multiplication of 2 matrices
9. String
  - a) Program to accept a string and display it as reverse using C language
  - b) program to concatenate 2 string using C
10. Array
  - a) Program to illustrate the concepts of arrays
  - b) Program to illustrate pointer to 2-dimensional array
11. Program to take mark details of students and display the name of the students with highest marks using Structure concept
12. Program to implement union concept

### COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1</b>	Acquire foundational knowledge of programming including Algorithm, Flowcharts, assembly language basics, Program structure.
<b>CO2</b>	Understand C language fundamentals
<b>CO3</b>	Apply various types of arrays and string manipulation technique to manage and process data in programming scenarios
<b>CO4</b>	Analyze and experiment with functions, develop recursive solutions and pointers to solve complex problems.
<b>CO5</b>	Develop modular programs using control structures, unions

### Mapping of Course Outcomes (CO's) with PO's & PSO's

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>CO2</b>	<b>3</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>0</b>
<b>CO3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>0</b>	<b>1</b>	<b>1</b>
<b>CO4</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>1</b>
<b>CO5</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>0</b>	<b>1</b>

3 – High, 2 – Average, 1 – Low, 0-Null

<b>Programme</b>	<b>B. Tech CSE-AI&amp;ML</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR113</b>	<b>Number of Hours/Week</b>	<b>4</b>			
<b>Semester</b>	<b>I</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>4</b>			
<b>Applied Science Course</b>						
<b>Course Title</b>	<b>MATHEMATICS-I</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>1</b>	<b>0</b>
<b>COURSE OBJECTIVES:</b>						
The main learning objective of this course is to prepare the students for:						
<ul style="list-style-type: none"> <li>• To recall and remember basics of matrices, complex numbers, and differential calculus.</li> <li>• To understand the concepts of basic mathematical methods for matrices, complex numbers and differential calculus.</li> <li>• To apply methods to solve engineering problems.</li> <li>• To analyze engineering problems and evaluate.</li> <li>• To solve and evaluate the problems using matrices, complex numbers, and differential calculus.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to Differentiation and its applications:</b> Fundamentals of Differentiation, Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders, Indeterminate forms and L'Hopital's rule, Maxima and Minima				<b>10</b>	
<b>II</b>	<b>Integration and its applications:</b> Double integral, Triple integral, Change of order of integration, Change of variables, Beta and Gamma functions and their properties, Dirichlet's integral and its applications to area and volume, Liouville's extensions of Dirichlet's integral.				<b>12</b>	
<b>III</b>	<b>Sequence:</b> Real number system, Convergence of sequence and series, Tests for convergence				<b>8</b>	
<b>IV</b>	<b>Series:</b> Power series, Taylor's series, Series for exponential, trigonometric and logarithm functions, Fourier series: Half range sine and cosine series, Parseval's theorem.				<b>8</b>	
<b>V</b>	<b>Advanced Multivariable Calculus:</b> Limit, continuity and partial derivatives, Directional derivatives, Total derivative, Tangent plane and normal line, Maxima, minima and saddle points, Method of Lagrange multipliers, Gradient, curl and divergence				<b>10</b>	
<b>VI</b>	<b>Advanced Matrix Theory:</b> Introduction, types of matrices-symmetric, skew-symmetric, Hermitian, skew-Hermitian, orthogonal, unitary matrices, Rank of a matrix - echelon form, normal form, consistency of system of linear equations (Homogeneous and Non-Homogeneous). Inverse and rank of a matrix, rank-nullity theorem				<b>12</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

CO1:	Understand the concepts of mean value theorems, higher order derivative, series expansion and associated problems
CO2:	Acquire problem solving skills for finding area and volume using multiple integrals
CO3	Analyze sequences and series, including Fourier series
CO4	Apply the differentiation of functions of two variables for maximization and minimization
CO5	Evaluate basic matrix operations, linear systems of equations

### **Text Books**

- 1: Advanced Engineering Mathematics, 10<sup>th</sup> Edition, Erwin Kreyszig, 1998.
- 2: Calculus and Analytical Geometry, Thomas and Finney, 1996.
- 3: Engineering Mathematics-I, Veerarajan T., , Tata McGraw-Hill, New Delhi, 2008.
- 4: Higher Engineering Mathematics, Ramana B.V., , Tata McGraw Hill New Delhi, 11<sup>th</sup> Reprint, 2010.

### **Reference Books**

- 1: Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, 36th Edition, 2010.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>	<b>1</b>
<b>CO2</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>1</b>
<b>CO3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>2</b>
<b>CO4</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>2</b>
<b>CO5</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>1</b>

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE-AI &amp; Robotics</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR114</b>	<b>Number of Hours/Week</b>	<b>4</b>			
<b>Semester</b>	<b>I</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>4</b>			
<b>Applied Science Course</b>						
<b>Course Title</b>	<b>PHYSICS I</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>1</b>	<b>0</b>	
<b>L-Lecture Hours</b>	<b>T-Tutorial Hours</b>	<b>P-Practical Hours</b>				
<b>COURSE OBJECTIVES:</b>						
<ul style="list-style-type: none"> <li>To impart knowledge on the basics of the vector and scalar representation of forces and moments with Special reference to differentiation and integration methods</li> <li>To acquire knowledge on moment of inertia and angular momentum</li> <li>To impart knowledge on the concept of central force problems and uniformly accelerating systems.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	Algebra of vectors-Describing motion: displacement, velocity,speed, acceleration; Cartesian, polar,spherical, and cylindrical polar coordinates; Mathematical tools- differentiation and integration methods, Taylor's series				<b>12</b>	
<b>II</b>	Concept of inertia; concept of inertial and non-inertial frames; Newton's laws of motion; Application of Newton's laws: particles in gravitational field, simple harmonic motion, tension in a string, frictional force, viscous force, damped harmonic oscillator, forced harmonic oscillator and resonance.Concept of momentum- center of mass, conservation of momentum, momentum and flow of mass, work-energy theorem, conservative and non-conservative forces, conservation of energy, concept of power, conservation laws and particle collisions				<b>12</b>	
<b>III</b>	Concept of moment of inertia; fixed axis rotation; angular displacement, angular velocity, and angular acceleration; vector nature of angular velocity; angular momentum; torque; conservation of angular momentum; gyroscope motion				<b>12</b>	
<b>IV</b>	Central forces; central force motion as one-body problem;conservation laws in central forcemotion; Kepler's laws				<b>12</b>	
<b>V</b>	Galilean transformations; uniformly accelerating systems; principle of equivalence; Physics in rotating coordinatesystems				<b>12</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Apply the concepts of polar, rectangular, cylindrical and spherical coordinates systems.

**CO2:** Ability to differentiate statics and kinematics.

**CO3:** Demonstrate the ability to solve the problems in Newton's laws.

**CO4:** Appreciate to understand rotational kinetic energy & angular momentum.

**CO5:** Acquire adequate knowledge on conservation laws.

## **Text Books:**

1. An Introduction to Mechanics by Daniel Kleppner, Robert Kolenkow, 2<sup>nd</sup> edition, 2006.

## **Reference Books:**

2. Mechanics: Course of Theoretical Physics - Vol. 1, L.D. Landau and E.M. Lifshitz, Third Edition, CBS Publishers, 2002.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	3	0	0	0	0	0	0	0	0	0	2	0	0	2
<b>CO2</b>	2	0	0	1	0	0	0	0	0	0	0	0	0	0	2
<b>CO3</b>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2
<b>CO4</b>	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>CO5</b>	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0

3 – High, 2 – Average, 1 – Low, 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25AEEN911</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>1</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>1</b>	<b>Credits</b>	<b>3</b>			
<b>Ability Enhancement Compulsory Course (AECC)</b>						
<b>Course Title</b>	<b>EFFECTIVE COMMUNICATION</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours</b>	<b>T-Tutorial Hours</b>	<b>P-Practical Hours</b>				
<b>COURSE OBJECTIVES:</b>						
<p>The main learning objective of this course is to prepare the students to</p> <ul style="list-style-type: none"> <li>• To define and explain the fundamental concepts, types, and processes of communication.</li> <li>• To develop active listening and effective speaking skills to enhance interpersonal communications.</li> <li>• To improve reading comprehension skills through different techniques.</li> <li>• To apply grammar and vocabulary rules and public communication for accurate sentence structure and effective written communication.</li> <li>• To prepare and deliver effective presentations by planning, structuring, and overcoming stage fright.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to Communication</b> Definition of Communication, Types of Communication: Formal, Informal, Oral, Written, Verbal, non-verbal, interpersonal, intrapersonal Process of Communication: Sender, Message, Channel, Receiver, Feedback Barriers: Intrapersonal, Interpersonal, Organizational Overcoming Barriers				<b>10</b>	
<b>II</b>	<b>Listening and Speaking:</b> Active Listening: Types of Listening, Reasons for poor listening Traits of the good listener, Effective Speaking: Achieving Confidence, Clarity, and Fluency, Public Speaking, Drafting the Speech				<b>10</b>	
<b>III</b>	<b>Reading and Writing:</b> Reading Comprehension: Improving Comprehension Skills, Scanning and Skimming, Predicting the Content, Understanding the Gist, PQRST Technique Grammar and Vocabulary: Sentence Structure, Preposition, Punctuation, Articles, Common errors and Correct Usage, Word formation: Affixes, Active and Passive Vocabulary				<b>13</b>	
<b>IV</b>	<b>Presentation Skills</b> Planning: Occasion, Audience, Purpose, Thesis Statement, Material, Outlining and Structuring, Guidelines for Effective Delivery, Strategies for Reducing Stage Fright				<b>8</b>	
<b>V</b>	<b>Practice:</b> Grammar Bites, English Fluency Drills				<b>4</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Analyse different types and processes of communication and the barriers that may arise.

**CO2:** Demonstrate active listening skills and strategies for confident and fluent public speaking.

**CO3:** Improve reading comprehension through effective reading techniques.

**CO4:** Apply proper grammar, sentence structures, and vocabulary for clear and correct written communication.

**CO5:** Create structured presentations, incorporating techniques to manage stage fright and engage the audience effectively.

## **Text Books**

1. Kumar, Sanjay and Pushp Lata. *Communication Skills*. 2<sup>nd</sup>. ed., Oxford University Press, 2015.
2. Raman, Meenakshi and Sangeetha Sharma. *Technical Communication: Principles and Practice*, 4th ed., Oxford University Press, 2022.

## **Reference Books**

1. Adair, John. *Effective Communication: The Most Important Management Skill of All*. Pan Books Publishers, 1997.
2. Gorrell, Robert M and Charlton Laird. *Modern English Handbook*. 6<sup>th</sup> ed., Pentice Hall Publications, 1976.
3. Rose, William. *GNVQ Core Skills Communication*. 2<sup>nd</sup>. ed., Pitman Publishing, 1995.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
<b>CO2</b>	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0
<b>CO3</b>	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
<b>CO4</b>	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1
<b>CO5</b>	0	0	0	0	0	0	0	0	3	3	0	0	0	0	2

3 – High, 2 – Average, 1 – Low , 0-Null

# **Semester II**

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR121</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>II</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>PYTHON PROGRAMMING</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<p><b>COURSE OBJECTIVES:</b></p> <p>The main learning objective of this course is to prepare the students for:</p> <ul style="list-style-type: none"> <li>• To Understand the fundamentals of the Python programming language and its historical development</li> <li>• To Master Python basics, including data types, operators, tuples, dictionaries, and string manipulation.</li> <li>• To demonstrate object oriented concept in python</li> <li>• To familiarize with machine learning tools in python</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<p><b>Introduction to python programming</b>  Introduction to python ; setting up python programming environment; variables; strings and its operations; special characters; striping whitespace; numbers; comments; list and its operations; indexing; looping through lists; indentation; range function; slicing a list; copying list; looping through slice;</p>				<b>9</b>	
<b>II</b>	<p><b>Python datatypes</b>  Tuples and its operations; relational operators; conditional statements – if, if-else, if-elif-else; multiple conditional blocks; dictionaries; key-value pairs – adding, modifying, removing; looping through dictionary; list of dictionaries; dictionary in a dictionary; user input function; type casting;</p>				<b>9</b>	
<b>III</b>	<p><b>Loop and function</b>  While loop; break and continue; functions; arguments; passing arguments – positional arguments, keyword arguments, default values; optional arguments; returning from function; passing arbitrary number of arguments; storing functions in modules; import specific function or module;</p>				<b>9</b>	
<b>IV</b>	<p><b>OOPs in python</b>  Classes;_init_() method; instance of a class; accessing attributes;calling methods; creating multiple instances; inheritance – parent class, child class; importing classes; files – reading a file, writing to a file, appending to a file; exceptions – try-except block, else block;</p>				<b>9</b>	
<b>V</b>	<p><b>Python machine learning tools</b>  Python tools for machine learning; python modules – numpy, pandas, matplotlib, scipy; python based machine learning libraries – pytorch, tensorflow; virtual environment; machine learning application using python tools;</p>				<b>9</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1** : Comprehend the holistic view of programming language design and behavior

**CO2** : Understand the programming concepts in abstract and paradigm level

**CO3** : Structure python programs for solving problems

**CO4** : Develop python programs using OOP concept

**CO5** : Execute ML project using python tools

## **Text Books:**

1. A Hands-On, Project-Based Introduction to Programming, Eric Matthes. Python Crash Course, 2nd Edition:No Starch Press, Inc., 2019.

## **Reference Books:**

1. Boring Stuff with Python by Al Sweigart. AutomA ,William Pollock, 2015.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	1	3	0	0	1	0	1	0	1	0	2	0	1	1
<b>CO2</b>	3	3	2	3	1	2	0	2	1	1	0	2	1	1	2
<b>CO3</b>	3	2	3	2	3	1	1	0	0	1	0	2	2	2	2
<b>CO4</b>	3	2	3	2	1	2	1	0	1	1	0	1	2	1	3
<b>CO5</b>	2	2	3	3	3	0	1	3	1	1	1	1	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR221</b>	<b>Number of Hours/WK</b>	<b>2</b>			
<b>Semester</b>	<b>II</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credit</b>	<b>1</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>PYTHON PROGRAMMING LABORATORY</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>0</b>	<b>0</b>	<b>2</b>

Course Objective:

The main learning objective of this course is to prepare the students for:

1. To learn fundamentals in python programming language
2. To introduce python modules for application
3. To familiarize python framework for machine learning applications
4. To develop machine learning application using python
5. To implement research topic as part of python project

List of experiments:

S.NO	TITLE
1	Implement basic algebraic problems to get into pythonprogramming
2	Implement string manipulations problems using python
3	Implement problems using python datatypes such astuple, list, dictionary etc.
4	Implement problems for python loops, conditionalstatements and functions
5	Implement object oriented programming concepts inpython to solve different problems
6	Implement problems for python file manipulations
7	Implement standard machine learning algorithms usingpython frameworks such as TensorFlow, PyTorch etc.
8	Implement advanced problems using python tools in avirtual environment as part of python project

Course outcome:

On successful completion of this course, the student will be able to

CO1 : Develop basic coding skills in python

CO2 : Understand python datatypes, modules, frameworks etc.

CO3 : Implement standard ML algorithms using python tools

CO4 : Apply python frameworks for ML applications

CO5 : Create ML model for existing problems

### Mapping of Course Outcomes (CO's) with PO's & PSO's

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	1	3	0	0	1	0	1	0	1	0	2	0	0	2
<b>CO2</b>	3	3	2	3	1	2	0	2	1	1	0	2	0	1	2
<b>CO3</b>	3	2	3	2	3	1	1	0	0	1	0	2	2	2	3
<b>CO4</b>	3	2	3	2	1	2	1	0	1	1	0	1	2	3	3
<b>CO5</b>	2	2	3	3	3	0	1	3	1	1	1	1	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp;Robotics)</b>	<b>Programme Code</b>	<b>BTAR</b>		
<b>Course Code</b>	<b>25BTAR122</b>	<b>Number of Hours/Week</b>	<b>3</b>		
<b>Semester</b>	<b>II</b>	<b>Max. Marks</b>	<b>100</b>		
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>3</b>		
<b>Applied Science Course</b>					
<b>Course Title</b>	<b>PROBABILITY, STATISTICS AND STOCHASTIC PROCESSES</b>	<b>L</b>	<b>T</b>	<b>P</b>	
		<b>3</b>	<b>0</b>	<b>0</b>	
<p><b>COURSE OBJECTIVES:</b></p> <ul style="list-style-type: none"> <li>• <b>Understand fundamental probability concepts</b> and their applications in real-world scenarios.</li> <li>• Analyze data using descriptive statistics <b>such as mean, variance, and standard deviation.</b></li> <li>• Apply probability distributions (<b>e.g., binomial, normal</b>) <b>to model and solve problems.</b></li> <li>• Conduct hypothesis testing and confidence intervals <b>to make informed statistical inferences.</b></li> <li>• Utilize statistical tools and software <b>for data analysis and decision-making in various fields.</b></li> </ul>					
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>
<b>I</b>	<b>Introduction to Probability:</b> Introduction to set algebra-sigma algebra-Borel sigma algebra-sequence of sets and its limits-lim-sup and lim-inf of sequence of sets; Axiomatic definition of probability-probability space-properties of probability functions-conditional probability-Bayes' rule-independence of events-continuity of probability functions-Borel Cantelli lemmas.				<b>10</b>
<b>II</b>	<b>Random variables</b> -distribution function and its property probability mass and density functions-symmetric distribution and its properties-expectation-moments moment generating function-Markov inequality-Chebyshev's inequality.				<b>8</b>
<b>III</b>	<b>Joint distributions</b> -marginal and conditional distributions-moments-independence of random variables-covariance, and correlation joint moment generating functions-additive properties of random variables-functions of random variables-ordered Statistics.				<b>8</b>

<b>IV</b>	<b>Special distributions:</b> Discrete uniform-Bernoulli-binomial-geometric negative binomial-hypergeometric-Poisson-exponential-gamma-normal-bivariate normal distribution; Population- sample-parameters- distributions of the sample mean and the sample variance for a normal population-Chi-Square-t, F distributions-law of large numbers–central limit theorem-point estimation-method of moments-maximum likelihood estimator-unbiasedness.	<b>9</b>
<b>V</b>	<b>Testing of hypothesis:</b> Null and alternate hypothesis-Neyman Pearson fundamental lemma and its applications-tests for one sample and two sample problems for normal populations-tests for proportions- confidence interval estimation-confidence interval for parameters of normal population	<b>10</b>

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1: Understand Basic Probability Concepts
- CO2: Analyse Random Variables and Probability Distributions, Joint Distributions and Conditional Probability
- CO3: Implement the Central Limit Theorem and Law of Large Numbers
- CO4: Perform Hypothesis Testing and Statistical Inference, Regression and Correlation for Data Analysis
- CO5: Employ Statistical Tools in Engineering Applications

### **Text Books:**

1. First Course in Probability, Sheldon Ross, 2022.
2. An Introduction to Probability and Statistics, V.K. Rohatgi and A.K. Md. E. Saleh, 2015.

### **Reference Books:**

1. Introduction to Probability and Statistics, S. Milton and J.C. Arnold, 2003.
2. Introduction to Mathematical Statistics, R V Hogg, A Craig and J W McKean, 2019

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	2	1	0	1	0	0	0	0	0	0	2	2	1	1
<b>CO2</b>	2	1	1	2	1	2	1	0	1	2	1	2	1	2	1
<b>CO3</b>	2	0	2	2	2	2	2	1	1	2	0	0	2	0	2
<b>CO4</b>	2	2	1	2	0	2	2	1	0	0	1	1	2	2	2
<b>CO5</b>	2	2	0	2	1	2	2	2	1	1	2	2	0	0	2

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp;Robotics)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR123</b>	<b>Number of Hours/Week</b>	<b>4</b>			
<b>Semester</b>	<b>II</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>4</b>			
<b>Applied Science Course</b>						
<b>Course Title</b>	<b>MATHEMATICS II</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>1</b>	<b>0</b>
<b>COURSE OBJECTIVES:</b>						
<ul style="list-style-type: none"> <li>• To develop a strong understanding of vector spaces, subspaces, basis, and dimension, as well as how linear transformations relate to matrices and their properties.</li> <li>• To gain proficiency in solving systems of linear equations using techniques like Gaussian elimination, matrix operations, and determinants.</li> <li>• To compute eigenvalues and eigenvectors, and apply them to diagonalize matrices, a critical tool for solving differential equations.</li> <li>• To solve first-order and second-order ordinary differential equations (ODEs) with applications to physical, biological, and engineering problems.</li> <li>• To understand the interplay between linear algebra and differential equations, especially in systems of linear differential equations, using matrix methods such as the Laplace transform and matrix exponentials.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Advanced Matrix Theory: Systems of linear equations:</b> Elementary operations-row-reduced echelon matrices-Gauss elimination LU factorization-linear independence-rank of a matrix-solutions of linear systems-existence and uniqueness.				<b>12</b>	
<b>II</b>	<b>Vector spaces:</b> Vector space-subspaces-spanning space-bases and dimensions. Linear transformation-matrix representations of linear transformations-range space and rank-null space and nullity-the rank and nullity theorem-invertibility.				<b>12</b>	
<b>III</b>	<b>Eigenvalues and eigenvectors:</b> Eigen values-eigenvectors and some applications of eigenvalue problems-Hermitian, skew-Hermitian, unitary matrices and their eigenvalues-eigen bases.				<b>12</b>	
<b>IV</b>	<b>Elementary Canonical Forms:</b> Diagonalization: Annihilating polynomial-the minimal polynomial and the characteristic polynomial-Cayley-Hamilton theorem-real quadratic form; Inner product spaces: Inner product spaces-orthonormal bases- Gram-Schmidt process.				<b>12</b>	
<b>V</b>	<b>Ordinary Differential Equations:</b> Review of First Order ODE-Lipschitz condition-Picard's theorem; Linear differential equations: Linear dependence and Wronskian-linear ODE with constant coefficients of higher order characteristic equations- Cauchy-Euler equations-method of undetermined coefficients-method of variation of parameters-solutions methods using Laplace Transform				<b>12</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- Learn different types of matrices, concept of rank, methods of matrix inversion and their applications, systems of linear equations, and manipulate vectors in various dimensions.
- Understand linear spaces, its basis and dimension with corresponding applications in the field of computerscience.
- Apply the concept of eigen values, eigen vectors, diagonalisation of matrices and orthogonalization in innerproduct spaces for understanding physical and engineering problems.
- Understand the first- and second-order ordinary differential equations (ODEs), both analytically and numerically, with applications to real-world phenomena.
- Develop the skills to model physical systems using differential equations and linear algebra.

## **Text Books:**

- Linear Algebra, Hoffman Kunze, 2015.
- Differential Equations, S. L Ross, 2007.

## **Reference Books:**

- Introduction to Linear Algebra, Gilbert Strang, 2016.
- Advanced Engineering Mathematics, Erwin Kreyszig, 2010.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	2	1	0	1	0	0	0	0	0	0	2	2	1	1
<b>CO2</b>	2	1	1	2	1	2	1	0	1	2	1	2	1	2	1
<b>CO3</b>	2	0	2	2	2	2	2	1	1	2	0	0	2	0	2
<b>CO4</b>	2	2	1	2	0	2	2	1	0	0	1	1	2	2	2
<b>CO5</b>	2	2	0	2	1	2	2	2	1	1	2	2	0	0	2

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR124</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>II</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>3</b>			
<b>Applied Science Course</b>						
<b>Course Title</b>	<b>PHYSICS II</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours</b>	<b>T-Tutorial Hours</b>	<b>P-Practical Hours</b>				
<b>COURSE OBJECTIVES:</b>						
<ul style="list-style-type: none"> <li>• To understand the working principle of various lasers, fibre optics and its applications.</li> <li>• To impart knowledge on acoustics and ultrasonics and its applications.</li> <li>• To provide knowledge on magnetism and superconducting phenomenon.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	Introduction – Components of laser – Principle of laser action – Properties of laser – Spontaneous emission and stimulated emission – Einstein’s coefficients – Population inversion – Types of lasers – He-Ne laser – Nd-YAG laser – Semiconductor laser – Industrial applications of laser – Medical applications of laser – Holography				<b>9</b>	
<b>II</b>	Introduction – Propagation of light in optical fiber – Total internal reflection – Principle of optical fiber – Fractional Refractive index - Numerical aperture and acceptance angle – Types of optical fibers based on materials, modes of propagation and refractive index profile – Power losses in optical fibers – Fiber optic communication system – Fiber optic sensors – Temperature and Displacement – Fibre endoscope				<b>9</b>	
<b>III</b>	Introduction – Classification of sound – Characteristics of musical sound – Pitch – Loudness – Quality – Intensity of sound – Weber Fechner Law – Reverberation – Reverberation Time – Sabine’s Formula – Factors affecting the acoustics of a building – Absorption Coefficient – Measurement of Absorption coefficient				<b>9</b>	
<b>IV</b>	Introduction – Production of ultrasonic waves – Magnetostriction Effect – Magnetostriction generator – Piezoelectric Effect – Properties of ultrasonics - Acoustic grating – Applications of ultrasonics – Industrial applications – SONAR – NDT — Medical Applications				<b>9</b>	
<b>V</b>	Types of electronic materials: metals, semiconductors, and insulators, Dia, Para, Ferro magnetic materials properties, Temperature effects - Hysteresis curve, Hard and soft magnetic engineering materials - Applications: Magnetic recording and reading – Hard disc. Superconductors: Properties of superconducting materials - Type I and Type II superconductors- Applications: Maglev.				<b>9</b>	

## COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- CO1:** Understand the concept of lasers and apply laser action in industries.
- CO2:** Explain and interpret the principle of fiber optics for different types of industrial sensors.
- CO3:** Discern the laws governing acoustics and implement the same in acoustic quieting.
- CO4:** Apply the fundamentals of ultrasonics in non-destructive testing.
- CO5:** Evaluate and perceive various laws governing magnetism with special reference to magnetic confinement for future power generation.

### Text Books:

1. Engineering Physics, D.K. Bhattacharya and Poonam Tandon, New Delhi: Oxford University Press (2017)
2. Engineering Physics, S.Mani Naidu, New Delhi: Pearson India Education Services Pvt. Ltd., (2014)

### Reference Books:

1. Engineering Physics, R.K. Gaur and S.L.Gupta, New Delhi: Dhanpat Rai Publications (P) Ltd. (2008)
2. Engineering Physics, Shatendra Sharma and Jyotsna Sharma, New Delhi: Pearson India Education Services Pvt. Ltd., (2019)
3. Engineering Physics, Dattu R. Joshi, New Delhi: Tata McGraw Hill Education Private Ltd., (2010)
4. A Textbook of Engineering Physics, M. N. Avadhanulu and P. G. Kshirsagar, New Delhi: S.Chand and Company Ltd., (2009)
5. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick, Wiley India Pvt. Ltd., New Delhi (2014), Tenth Edition
6. Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman, Pearson Education, New Delhi (2018), Fourteenth Edition.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	1	0	0	0	0	0	0	0	0	0	2	2	0	0
<b>CO2</b>	2	0	0	3	0	0	0	0	0	0	0	0	1	0	0
<b>CO3</b>	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
<b>CO4</b>	2	1	0	0	0	0	0	0	0	0	0	0	2	0	0
<b>CO5</b>	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp;Robotics)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR222</b>	<b>Number of Hours/Week</b>	<b>2</b>			
<b>Semester</b>	<b>II</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>1</b>			
<b>Applied Science Course</b>						
<b>Course Title</b>	<b>PHYSICS LAB</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>0</b>	<b>0</b>	<b>2</b>
<b>L-Lecture Hours</b>	<b>T-Tutorial Hours</b>	<b>P-Practical Hours</b>				
<p>At the end of the courses, the student will be able to</p> <ol style="list-style-type: none"> <li>1. Understand the concept of lasers and its action in industries.</li> <li>2. Explain the principle of fiber optics for different types of industrial sensors.</li> <li>3. Apply the basics of Lasers and Optical fibers.</li> <li>4. Study the principles and applications of acoustics.</li> <li>5. Discern the laws governing acoustics and its applications in acoustic quieting.</li> <li>6. Relate the application of light in optical devices.</li> </ol>						
<b><u>List of experiments</u></b>						
<b>1</b>	Wavelength Determination – LASER diffraction					
<b>2</b>	Particle size Determination – LASER diffraction					
<b>3</b>	Attenuation of an Optical fibre– Fibre Optic Cable					
<b>4</b>	Numerical Aperture measurement of an Optical Fibre– Fibre Optic Cable					
<b>5</b>	Determination of Planck’s constant – LED					
<b>6</b>	Reverberation Time of a hall - Acoustics					
<b>7</b>	Refractive index of a prism – Spectrometer					
<b>8</b>	Wavelength of Mercury spectrum – Diffraction grating – Spectrometer					

### Mapping of Course Outcomes (CO's) with PO's & PSO's

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	0	0	0	0	1	0	0	0	0	0	0	2	0	0	2
<b>CO2</b>	0	0	0	1	0	0	0	0	0	0	0	1	0	0	2
<b>CO3</b>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
<b>CO4</b>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
<b>CO5</b>	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR125</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>II</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>DISCRETE STRUCTURES FOR COMPUTER SCIENCE</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours</b>		<b>T-Tutorial Hours</b>		<b>P-Practical Hours</b>		
<b>COURSE OBJECTIVES:</b>						
<ul style="list-style-type: none"> <li>• To get familiar and understand the fundamental notions in discrete structures focusing on aspects of computer science</li> <li>• To describe binary relations between two sets, combine relations using set operations and composition.</li> <li>• To understand and demonstrate the basic concept of algorithm and its application in combinatorial mathematics.</li> <li>• To identify the base step and the recursive or inductive step in applied problems and give a recursive and a non-recursive definition for an iterative algorithm.</li> <li>• To classify the basic properties of graphs and trees and model simple applications.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Set Theory and Logic</b> Sets – Functions – Relations - Equivalence Relation – Poset - Functions Logic: Propositional logic - Truth Tables – Tautologies - Resolution Proof System - Predicate Logic				8	
<b>II</b>	<b>Induction and Combinatorics</b> Peano's Axioms - Mathematical Induction - Pigeon-Hole Principle - Principle of Inclusion and Exclusion - Review of Permutations and Combinations - Distribution Problems - Derangements - Bijection Principle.				8	
<b>III</b>	<b>Algebraic Structures</b> Semi-Groups – Monoids – Groups - Subgroups and Their Properties - Cyclic Groups - Cosets - Permutation Groups - Lagrange's Theorem - Cayley's Theorem - Normal Subgroups - Homomorphism of Groups - Quotient Groups –Introduction to Rings and Fields				9	
<b>IV</b>	<b>Linear Algebra and Recurrence Relations</b> Linear Algebra: Vector Space – Basis, Dimension, Orthogonality - Recurrence Relations: Homogeneous and Inhomogeneous Recurrences and their Solutions - Solving Recurrences Using Generating Functions.				9	
<b>V</b>	<b>Graph Theory</b> Definitions and Basic Results - Representation of a Graph by a Matrix and Adjacency List - Trees - Cycles - Properties - Paths and Connectedness - Subgraphs - Graph Isomorphism - Operations on Graphs - Vertex and Edge Cuts - Vertex and Edge Connectivity.				9	

### **COURSE OUTCOMES:**

- On successful completion of this course, the student will be able to
- Understand the fundamental aspects of discrete and continuous mathematical structures.
- Demonstrate the principles of mathematical induction to prove statements.
- Differentiate between various algebraic structures and analyze their properties.
- Apply logical reasoning and mathematical techniques to solve problems in set theory, algebra and graph theory.
- Construct new mathematical models thereby generating solutions to complex recurrence relations and graph problems.

### **Text Books**

1. “Elements of Discrete Mathematics: A Computer Oriented Approach”, C. L. Liu, D. P. Mohapatra, McGraw Hill, Third Edition, 2012.
2. “Applied Discrete Structures”, Al Doerr, Ken Levasseur, LibreTexts, Third Edition, 2023

### **Reference Books**

1. “Discrete Mathematical Structures with applications to Computer Science”, Tremblay J.P. and Manohar R., McGraw Hill International Edition, 1987.
2. “Discrete Mathematics and Its Applications”, Kenneth H. Rosen, Sixth Edition, Tata McGraw Hill, 2012.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	1	0	0	1	2	0	0	0	0	1	2	0	0	3
<b>CO2</b>	1	2	1	1	1	0	0	0	0	0	1	0	0	1	3
<b>CO3</b>	2	1	1	2	0	0	0	0	0	0	1	1	0	0	2
<b>CO4</b>	2	2	1	1	0	0	0	0	0	0	2	2	1	1	1
<b>CO5</b>	3	2	1	2	3	0	0	0	0	0	1	1	0	2	2

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25EVST921</b>	<b>Number of Hours/Week</b>	<b>2</b>			
<b>Semester</b>	<b>II</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>I</b>	<b>Credits</b>	<b>2</b>			
<b>Value Added Course</b>						
<b>Course Title</b>	<b>ENVIRONMENTAL SCIENCE</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>2</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours      T-Tutorial Hours      P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
The main learning objective of this course is to prepare the students to:						
<ul style="list-style-type: none"> <li>• To understand the Environmental Foundations</li> <li>• To differentiate between renewable and non-renewable resources and assess the impacts of land use changes, land degradation, and water resource exploitation.</li> <li>• To study the causes and effects of pollution and its impacts on earth</li> <li>• To analyse the population causes, its effects and control measures.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to Environmental studies</b> Definition and Scope of Environmental Studies - Interdisciplinary Nature of Environmental Science-Historical Perspectives on Environmental Issues-Principles of Sustainability and Sustainable Development, Ecosystem- Structure and functions of ecosystem--Aquatic ecosystems				<b>6</b>	
<b>II</b>	<b>Natural Resources- Renewable and Non-renewable Resources</b> Land resources and land use change, Land degradation, soil erosion, Desertification- Deforestation- exploitation of surface and ground water, floods, droughts, conflicts over water Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.				<b>6</b>	
<b>III</b>	<b>Biodiversity and Conservation</b> Levels of biological diversity- genetic, species and ecosystem diversity, Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots.				<b>6</b>	
<b>IV</b>	<b>Environmental Pollution</b> Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution - Nuclear hazards and human health risks-Solid waste management: Control measures of urban and industrial waste. Pollution case studies, Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture, Environment Laws: Environment Protection Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD), Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.				<b>12</b>	

<b>V</b>	<b>Human Communities and the Environment</b> Human population growth: Impacts on environment, human health and welfare- Resettlement and rehabilitation of project affected persons, Disaster management: floods, earthquake, cyclones and landslides, Environmental movements- Chipko, Silent valley, Bishnoi's of Rajasthan	<b>10</b>
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### **Andragogy**

Class Room Lectures, Power point presentation, You Tube, Group Discussion, Seminar, Quiz, Formative Assessments, Brain storming, Activity.

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1:</b>	Define environmental studies and its interdisciplinary nature
<b>CO2:</b>	Analyze the structure and functions of various ecosystems, including aquatic ecosystems.
<b>CO3:</b>	Evaluate the growing energy needs and the role of alternative energy sources
<b>CO4:</b>	Understand levels of biodiversity (genetic, species, and ecosystem) and identify biodiversity hotspots, with a focus on conservation strategies.
<b>CO5:</b>	Evaluate the effects of human population growth on the environment and the importance of disaster management, resettlement, and environmental movements

### **Textbooks**

1. Environmental and Sustainable Development, Keiji Ujikawa, Mikio Ishiwatari, Eric van Hullebusch, 1<sup>st</sup> Edition springer publishers Singapore, 2022.
2. Environmental Science: Toward A Sustainable Future, Dorothy F. Bourse and Richard T. Wright, 13th edition, Pearson publishers, 2017.
3. Social Learning in Environmental Management: Towards a Sustainable Future, Meg Keen, Valerie A. Brown, Rob Dyball, 2012.
4. Principles of Environmental Science, William P. Cunningham and Mary Ann Cunningham, 10th edition, Mc graw hill publishers, 2004.
5. Visualizing Environmental Science, Linda R. Berg, Mary Catherine Hager and David M. Hassenzahl, 2017.

### **Reference Books:**

1. Waste Water Treatment, Rao, M.N., Datta, A.K., Oxford and IBH Publishing Co. Pvt. Ltd, 1987.
2. Fundamentals of Ecology, Odum, E.P., Odum, H.T., and Andrews, J., , Saunders, Philadelphia, 1971, USA.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0
<b>CO2</b>	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
<b>CO3</b>	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
<b>CO4</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>CO5</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

3 – High, 2 – Average, 1 – Low , 0-Null

# **Semester III**

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR131</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>III</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>ARTIFICIAL INTELLIGENCE</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>COURSE OBJECTIVES:</b>						
<p>The main learning objective of this course is to prepare the students for:</p> <ul style="list-style-type: none"> <li>• To explore history and revolution of artificial intelligence</li> <li>• To formulate artificial intelligence problem by defining intelligent agent and its environment</li> <li>• To learn problem solving approaches through state space search and its different algorithms.</li> <li>• To develop an AI model with the help of concepts such as state space search, adversarial search, knowledge representation, inference etc.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to AI</b> Introducing the structure and scope of the course; Introduction and History of AI; Turing Test; Chinese Room Argument; Milestones in AI; AI Project Discussion – Problem finding, Project resources, Report writing; Intelligent agent – Sensors and Actuators; Examples of Agents; Rationality – perfect and bounded rationality;				<b>9</b>	
<b>II</b>	<b>Intelligent agent and state space search</b> Intelligent agent and its environment; Types of environments; Multi-agent environment; Structure of the agent – table based agent, percept based agent, state based agent, goal based agent, utility based agent; Subsumption architecture; Learning agent; State and State space definition; State space search; Problem formulation; 8 Queens problem; 8 Puzzle problem; Problem formulation examples;				<b>9</b>	
<b>III</b>	<b>Uninformed and Informed Searches</b> Uninformed search – Breadth first search, Depth first search, Depth limited search, Iterative deepening search, Bidirectional search, Uniform cost search; Informed Search – Greedy best first search, A* search, Memory-bounded search; Heuristic function;				<b>9</b>	
<b>IV</b>	<b>Local search and adversarial search</b> Search in complex environment; Local search and optimizations problems; Hill-climbing search; Simulated annealing; Local beam search; Adversarial search; Game theory – Two-player zero-sum games – max and min, utility function, state space graph, game tree, tic-tac-toe example; Minimax search; Alpha-Beta pruning;				<b>9</b>	
<b>V</b>	<b>Constraint satisfaction and Knowledge representation</b> Constraint satisfaction problem; satisfiability; propagating constraints; forward checking; backward checking; Knowledge representation – Logic, Propositional logic, Reasoning, Modus Ponens; First order logic; quantifiers; Mathematics behind machine learning – Linear algebra basics				<b>9</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1 :** Describe the history behind artificial intelligence
- CO2 :** Illustrate fundamental AI concepts
- CO3 :** Demonstrate problem formulation in state space search
- CO4 :** Infers adversarial search with alpha-beta pruning
- CO5 :** Develop an AI model for existing problems

## **Text Books:**

1. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach. Prentice Hall Press, USA, 3rd edition, 2009

## **Reference Books:**

1. Ian J. Goodfellow, Yoshua Bengio, and Aaron Courville. Deep Learning. MIT Press, Cambridge, MA, USA, 2016.
2. Gilbert Strang. Introduction to Linear Algebra. Wellesley-Cambridge Press, USA, 5th edition, 2016.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	1	2	1	0	0	1	0	3	0	1	0	3	2	0	0
<b>CO2</b>	3	2	3	3	0	2	0	0	0	2	0	1	0	3	3
<b>CO3</b>	3	1	2	2	0	2	0	0	0	2	1	1	1	1	3
<b>CO4</b>	3	1	2	2	0	2	0	0	0	2	1	1	0	1	2
<b>CO5</b>	2	2	3	3	3	1	3	3	3	2	2	1	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp;RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR132</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>III</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>SIGNALS AND SYSTEMS</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>COURSE OBJECTIVES:</b>						
The main aim of learning this course is:						
<ul style="list-style-type: none"> <li>• Understanding the fundamental characteristics of signals and systems.</li> <li>• Understanding the concepts of vector space, inner product space and orthogonal series.</li> <li>• Understanding signals and systems in terms of both the time and transform domains, taking advantage of the complementary insights and tools that these different perspectives provide.</li> <li>• Development of the mathematical skills to solve problems involving convolution, filtering, modulation and sampling.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Classification of Signals:</b> Continuous-time vs discrete-time signals, analog vs digital signals, energy and power signals, deterministic vs random signals. <b>Signal Operations:</b> Scaling, time shifting, time inversion, and time scaling of signals. <b>Signal Properties:</b> Symmetry (even and odd signals), periodicity of signals, and absolute integrability. <b>Elementary Signals:</b> Unit step, unit impulse, ramp, exponential, sinusoidal signals.				<b>9</b>	
<b>II</b>	<b>Systems:</b> Classification of Systems: Continuous-time vs discrete-time systems, linear vs nonlinear systems, causal vs non-causal systems, time-invariant vs time-varying systems, stable vs unstable systems. <b>System Properties:</b> Linearity, time/shift invariance, causality, and stability. <b>LTI and LSI Systems:</b> Continuous-time linear time-invariant (LTI) systems, discrete-time linear shift-invariant (LSI) systems. <b>Impulse and Step Response:</b> Impulse response and step response of systems. <b>Response to Arbitrary Input:</b> Convolution in continuous and discrete time domains. <b>System Representation:</b> Representation of systems using differential equations for continuous-time systems and difference equations for discrete-time systems.				<b>9</b>	
<b>III</b>	<b>Fourier Series and Transforms:</b> Fourier Series Representation: Fourier series representation of continuous-time periodic signals, Fourier series of discrete-time periodic signals, properties of Fourier series. <b>Continuous-Time Fourier Transform (CTFT):</b> Fourier transform of continuous-time signals, properties of CTFT (linearity, timeshifting, time scaling, etc.), Parseval's theorem, and time-bandwidth product. <b>Discrete-Time Fourier Transform (DTFT):</b> Fourier transform of discrete-time signals, properties of DTFT (linearity, time shifting, time scaling, etc.). <b>Relationships among Fourier Representations:</b> Relationship between Fourier series, CTFT, and DTFT.				<b>9</b>	
<b>IV</b>	<b>Laplace Transform and Sampling:</b> Laplace Transform: Definition of				<b>9</b>	

	the Laplace transform, region of convergence (ROC), properties of Laplace transforms (linearity, time shifting, scaling, initial value theorem, final value theorem, etc.), inverse Laplace transform. Sampling: Sampling theorem for bandlimited signals, aliasing in the sampling process, and Nyquist rate. Signal Reconstruction: Ideal signal reconstruction using interpolators, zero-order hold, and first-order hold methods.	
V	<b>Z-Transform and Discrete Fourier Transform:</b> Z-Transform: Definition of the z-transform, region of convergence (ROC) for z-transform, properties of the z-transform (linearity, time shifting, scaling, etc.), inverse z-transform (using partial fraction expansion and power series methods). Discrete Fourier Transform (DFT): Definition and properties of the DFT, relationship between DFT and DTFT, computation of DFT, inverse DFT.	9

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1 :** To Understand different types of signals-continuous and discrete, odd and even, periodic and aperiodic etc

**CO2 :** Be able to classify systems based on their properties

**CO3 :** To familiarize the concepts of transform based continuous time and discrete time

**CO4 :** Analyze continuous time and discrete time signals and systems by using appropriate mathematical tools

**CO5 :** Determine Fourier transforms for continuous-time and discrete-time signals (or impulse response functions), and understand how to interpret and plot Fourier transform magnitude and phase functions

### **Text Book**

1. "Signals and Systems" by Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, 1997.
2. D.C. Lay, Linear Algebra and its Applications (2/e), Pearson, 2016.
3. "Digital Signal Processing" by John G. Proakis, Dimitris G. Manolakis, 2007.

### **Reference Books**

1. "Signal Processing and Linear Systems" by B.P. Lathi, 1998.
2. "Signals and Systems: Continuous and Discrete" by Roger E. Ziemer, William H. Tranter, 1998

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
<b>CO1</b>	2	2	2	2	2	1	1	1	1	1	1	1	2	1	1
<b>CO2</b>	2	2	2	1	2	2	2	1	0	1	0	2	2	1	1
<b>CO3</b>	2	1	3	3	2	2	2	1	2	0	2	1	2	2	2
<b>CO4</b>	2	2	2	2	2	3	2	1	2	0	2	1	2	0	1
<b>CO5</b>	2	3	3	2	1	1	1	1	1	1	2	1	1	0	2

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp;RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR133</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>III</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>DIGITAL DESIGN</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>COURSE OBJECTIVES:</b>						
The main aim of this course is to prepare the students for:						
<ul style="list-style-type: none"> <li>• To teach various number systems, binary codes and their applications</li> <li>• To familiarize the students the importance of error detection and error correction codes.</li> <li>• To inculcate concepts of K-MAP to simplify a Boolean expression</li> <li>• To facilitate students in designing a logic circuit</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Number Representations:</b> Binary numbers: binary, octal, and hexadecimal number systems; conversion between different number systems; signed and unsigned numbers; representation of negative numbers using 1's complement and 2's complement. Integer representation: fixed-point number representation; range and precision of fixed-point numbers; overflow and underflow conditions. Floating- point representation, Arithmetic operations in binary: binary addition, subtraction, multiplication, and division; overflow detection and handling.				<b>7</b>	
<b>II</b>	<b>Combinatorial Circuits:</b> Boolean Algebra: fundamental theorems and postulates; simplification of Boolean expressions using algebraic techniques. Logic Gates: basic gates (AND, OR, NOT), universal gates (NAND, NOR), XOR and XNOR gates. Minimization of Boolean functions: simplification using Boolean identities; Karnaugh map (K-map) technique for 2, 3, 4, and 5 variables; don't care conditions in K-maps. Combinational Circuits: design and analysis of arithmetic circuits (adders, subtractors); code converters (Binary to Gray, Gray to Binary, BCD to Binary, etc.); multiplexers, demultiplexers, encoders, decoders.				<b>12</b>	
<b>III</b>	<b>Sequential Circuits:</b> Introduction to sequential circuits: difference between combinational and sequential circuits; clock signals and timing diagrams. Latches and Flip-Flops: SR Latch, D Latch, JK Flip-Flop, D Flip-Flop, T Flip-Flop; timing constraints: setup time, hold time, propagation delay. Counters: asynchronous (ripple) counters and synchronous counters; modulus of counters; design of up-down counters, ring counters, Johnson counters. Shift Registers: serial-in serial-out (SISO) registers, serial-in parallel-out (SIPO) registers, parallel-in serial-out (PISO) registers; applications of shift registers.				<b>12</b>	
<b>IV</b>	<b>Data Converters:</b> purpose of sample and hold circuits in digital signal processing; working principle and block diagram. Analog to Digital Converters (ADCs): working principle of ADCs and Digital to Analog Converters (DACs): working principle of DACs				<b>7</b>	
<b>V</b>	<b>Memory and Programmable Logic:</b> Introduction to memory: classification of memory: volatile vs non-volatile, primary vs secondary; characteristics of memory: access time, memory cycle time, and bandwidth. Random Access Memory (RAM): types of RAM: Static				<b>7</b>	

	RAM (SRAM) and Dynamic RAM (DRAM); memory cell architecture and organization. Memory decoding: address decoding techniques for RAM; row and column address selection. Read Only Memory (ROM): types of ROM: PROM, EPROM, EEPROM, Programmable Logic Array (PLA) architecture; Programmable Array Logic (PAL) structure	
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**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1 :** Understand various number systems and their arithmetic operations.
- CO2 :** Design and analyze combinatorial circuits using Boolean algebra, K-maps, and logicgates.
- CO3 :** Work with sequential circuits like latches, flip-flops, counters, and shift registers.
- CO4 :** Interface and design systems using data converters like ADCs and DACs.
- CO5 :** Explore different types of memory and programmable logic devices and apply them indigital systems.

**Text Book**

1. "Digital Design" by M. Morris Mano, Michael D. Ciletti, 2013.
2. Digital Systems: Principles and Applications" by Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss,2004.
3. "Microelectronics: Digital and Analog Circuits and Systems" by Jacob Millman and Arvin Grabel,1987.

**Reference Books**

1. Roth (2004), Fundamentals of Logic Design, 5th Edition, Thomson, India, 2018.
2. S. Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis,Pearson, 2nd Ed, 2003.
3. F. Vahid, Digital Design, 1st Ed., Wiley India, 2011.

**Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	1	0	1	0	0	0	0	0	0	2	2	1	1
<b>CO2</b>	3	3	3	2	3	2	1	0	1	2	1	2	3	2	1
<b>CO3</b>	3	3	3	2	2	2	2	1	1	2	0	0	2	0	2
<b>CO4</b>	3	2	3	2	3	2	2	1	0	0	1	1	2	2	2
<b>CO5</b>	3	3	3	2	3	2	2	2	1	1	2	2	3	0	2

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR 134</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>III</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>DATA STRUCTURE AND ALGORITHMS</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours</b>	<b>T-Tutorial Hours</b>	<b>P-Practical Hours</b>				
<b>COURSE OBJECTIVES:</b>						
The main learning objective of this course is to prepare the students for:						
<ul style="list-style-type: none"> <li>• To Comprehensive understanding of fundamental data structures and algorithms.</li> <li>• To equip algorithms with the skills to analyze and implement various computational techniques.</li> <li>• Learn to select appropriate data structures for solving complex problems, optimize algorithm performance, and gain insight into advanced topics such as dynamic programming and NP-completeness.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to Data Structures</b> Algorithms- asymptotic notations and analysis- Analysing Algorithms - Insertion sort, Divide and Conquer approach, Sorting, Building Heaps, Heap sort, Quick sort, Analysis of sorting algorithms,				<b>8</b>	
<b>II</b>	<b>Elementary data structures</b> Stacks and Queues, linked lists and its operations, Hash Tables - Direct and Open addressing- <b>Tree data structure</b> Tree- Tree Traversals-Binary Search Trees-Red Black Trees - Red-black trees and its operations. B-Tree-Insertion-Deletion.				<b>8</b>	
<b>III</b>	<b>Dynamic programming</b> Memoization, Tabulation, Rod Cutting, Matrix Chain Multiplication, Longest common subsequence, Greedy Algorithms- Introducing greedy approach, activity selection problem, Huffman codes, Graphs, Trees and Algorithms				<b>8</b>	
<b>IV</b>	<b>Introducing spanning trees,</b> Minimum spanning tree, algorithms, Kruskal, Prims, Bellman-Ford algorithm, Single source shortest path in directed acyclic graphs, Dijkstra's algorithms, Floyd-Warshall algorithm				<b>8</b>	
<b>V</b>	<b>NP-Completeness</b> Polynomial time, Verification algorithms, NP-Complete, NP-Hard				<b>8</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Understand the Fundamental Data Structures.

**CO2:** Applying the concept of stack,queue,list,binary search tree and Red black tree.

**CO3:** Analyzing the dynamic programming , greedy algorithms and binary search trees, including performing tree traversals, insertions, and deletions.

**CO4:** Utilize graph representations and perform operations.

**CO5:** Evaluating the implications of computational complexity for algorithm design and problem-solving strategies, including approaches for handling NP-Complete and NP- Hard problems.

## **Text Books:**

1. Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. MIT press, 2022.
2. Data Structures And Algorithms In C++, 2nd Edition by Michael T. Goodrich, 2014.
3. Data Structures and Algorithms Made Easy by Narasimha Karumanchi, 20323.
4. Fundamentals of Data Structures by Ellis Horowitz and Sartaj Sahni, 1978.

## **ReferenceBooks:**

1. Chitra.A, Rajan.P.T , (2016), *Data Structures*, Vijay Nicol Imprints Pvt Ltd, McGraw-Hill Education of India Pvt Ltd, India, SecondEdition.
2. Pai.G.A.V,( 2009), *Data Structures andAlgorithms*,TMH.
3. Samanta.D , (2006), *Classic Data Structures*, Prentice Hall of India Pvt Ltd, NewDelhi

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	0	2	3	1	0	2	1	1	0	2	2	2	0
<b>CO2</b>	3	3	2	2	3	1	0	2	1	2	1	2	2	3	3
<b>CO3</b>	3	3	3	3	2	1	1	2	2	1	1	3	2	3	3
<b>CO4</b>	2	3	3	3	3	2	2	3	2	2	2	3	3	3	3
<b>CO5</b>	2	3	3	3	3	2	2	3	2	2	2	3	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR135</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>III</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>OBJECT ORIENTED PROGRAMMING WITH JAVA</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students for:</b>						
<ul style="list-style-type: none"> <li>• To introduce the fundamentals of Java programming language.</li> <li>• To enable students to write object-oriented programs.</li> <li>• To familiarize students with advanced Java concepts like multithreading, exception handling, and collections.</li> <li>• To provide hands-on experience in developing real-world applications using Java.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Basics of Java Programming</b> Introduction to Java: Features, JVM, JDK, and JRE.-Writing, compiling, and executing Java programs.-Data types, variables, and operators.-Control structures: Decision-making, loops.-Arrays and Strings: Declaration, initialization, and operations.				<b>9</b>	
<b>II</b>	<b>Object-Oriented Programming in Java</b> Classes and Objects: Declaration, instantiation, and initialization.-Methods: Static, instance, and parameterized methods -Constructors and destructors.-Inheritance: Single, multilevel, hierarchical, and overriding.Polymorphism: Compile-time and runtime,Encapsulation and abstraction.Interfaces and abstract classes.				<b>9</b>	
<b>III</b>	<b>Exception Handling and Multithreading</b> Exception handling: Try-catch block, multiple catch, finally, throw, and throws. Built-in exceptions and user-defined exceptions. Multithreading: Thread lifecycle, creating threads -Thread class, Runnable interface. Thread synchronization and inter-thread communication.				<b>9</b>	
<b>IV</b>	<b>File I/O and Streams</b> Reading and writing files using FileReader, FileWriter, BufferedReader, and BufferedWriter. Byte and character streams. Serialization and deserialization.				<b>9</b>	
<b>V</b>	<b>GUI Programming and Event Handling</b> Introduction to AWT and Swing-Layout managers -FlowLayout, GridLayout, BorderLayout.Event handling: ActionListener, MouseListener, KeyListener. Creating simple GUI applications.				<b>9</b>	

### **Andragogy**

Class Room Lectures, Power point presentation, You Tube, Group Discussion, Seminar, Quiz, Formative Assessments, Brain storming, Activity

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1:</b>	Understand and apply Java syntax and semantics.
<b>CO2:</b>	Implement object-oriented programming concepts in Java.
<b>CO3:</b>	Develop Java applications with exception handling and multithreading.
<b>CO4:</b>	Use Java frameworks and APIs for GUI and database integration.
<b>CO5:</b>	Solve real-world problems using Java programming.

## **Text Books:**

1. "Programming in Java" by K. Somasundaram, by **PHI Learning Pvt. Ltd.**
2. "Java: The Complete Reference" by Herbert Schildt

## **Reference Books:**

1. "Thinking in Java" by Bruce Eckel
2. "Effective Java" by Joshua Bloch
3. "Java Programming for Beginners" by Mark Lassoff

## **Websites for Learning & Tools:**

1. **Oracle Java Tutorials**  
Website: <https://docs.oracle.com/javase/tutorial/>
2. **GeeksforGeeks - Java Programming**  
Website: <https://www.geeksforgeeks.org/java/>
3. **W3Schools - Java Tutorial**  
Website: <https://www.w3schools.com/java/>
4. **JavaTpoint**  
Website: <https://www.javatpoint.com/>

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	3	-	-	2	-	-	-	-	3	2	-
CO2	3	3	3	2	3	-	-	2	-	-	-	-	3	3	2
CO3	3	3	3	3	3	2	-	2	1	-	-	-	3	3	2
CO4	3	3	3	3	3	-	-	3	-	-	-	-	3	3	3
CO5	3	3	3	3	3	2	-	2	-	-	-	-	3	3	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR136</b>	<b>Number of Hours/Week</b>	<b>2</b>			
<b>Semester</b>	<b>III</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>2</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>PROFESSIONAL ETHICS</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>2</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours</b>	<b>T-Tutorial Hours</b>	<b>P-Practical Hours</b>				
<b>COURSE OBJECTIVES:</b>						
The main learning objective of this course is to prepare the students to						
<ul style="list-style-type: none"> <li>• To identify and understand key concepts of human values, including ethics, integrity, and professional responsibility.</li> <li>• To explore moral theories and frameworks related to engineering ethics, and analyze how these impact decision-making.</li> <li>• To evaluate the role of engineers in society through the lens of social experimentation, responsibility, and professional codes of conduct.</li> <li>• To assess safety and risk management principles, rights and responsibilities, including intellectual property and occupational ethics.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Human Values</b> Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character - Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.				<b>9</b>	
<b>II</b>	<b>Engineering Ethics</b> Senses of Engineering Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg’s theory – Gilligan’s theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest, Customs and Religion – Uses of Ethical Theories.				<b>9</b>	
<b>III</b>	<b>Engineering as Social Experimentation</b> Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.				<b>9</b>	
<b>IV</b>	<b>Safety, Responsibilities and Rights</b> Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.				<b>9</b>	
<b>V</b>	<b>Global issues</b> Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of Conduct – Corporate Social Responsibility				<b>9</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1:** Recognize the significance of human values and ethics in personal and professional life.
- CO2:** Analyze various moral theories and ethical dilemmas in engineering practices.
- CO3:** Evaluate the responsibilities of engineers as experimenters and decision-makers within legal and ethical frameworks.
- CO4:** Assess risk and safety issues, including intellectual property and employee rights in engineering contexts.
- CO5:** Apply ethical theories and frameworks to make informed engineering decisions.

## **Text Books:**

1. Naagarazan, R.S. A Textbook on Professional Ethics and Human Values, New Age International Limited Publishers: New Delhi, 2006.

## **Reference Books:**

1. Charles B. Fleddermann, —Engineering Ethics , Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, —Engineering Ethics – Concepts and Cases, Cengage Learning, 2009.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	0	0	0	0	0	2	0	0	2	2	0	0	1	0	0
<b>CO2</b>	0	0	0	0	0	0	0	0	0	3	0	0	2	0	0
<b>CO3</b>	0	0	0	0	0	0	0	0	0	3	0	0	2	0	0
<b>CO4</b>	0	0	0	0	0	0	0	0	0	3	0	0	2	0	0
<b>CO5</b>	0	0	0	0	0	0	2	0	0	3	0	0	1	0	0

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Pogramme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR231</b>	<b>Number of Hours/Week</b>	<b>2</b>			
<b>Semester</b>	<b>III</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>1</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>DIGITAL DESIGN LAB</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>0</b>	<b>0</b>	<b>2</b>
<b>Digital design lab list of experiments</b>						
<ol style="list-style-type: none"> <li>1. Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates</li> <li>2. Construction of half and full adder using XOR and NAND gates and verification of its operation</li> <li>3. To Study and Verify Half and Full Subtractor</li> <li>4. Realization of logic functions with the help of Universal Gates (NAND, NOR)</li> <li>5. Construction of a NOR gate latch and verification of its operation</li> <li>6. Verify the truth table of RS, JK, T and D flip-flops using NAND and NOR gates</li> <li>7. Design and Verify the 4-Bit Serial In - Parallel Out Shift Registers</li> <li>8. Implementation and verification of decoder or de-multiplexer and encoder using logic gates</li> <li>9. Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates</li> <li>10. Design and verify the 4- Bit Synchronous or Asynchronous Counter using JK Flip Flop</li> <li>11. Verify Binary to Gray and Gray to Binary conversion using NAND gates only</li> <li>12. Verify the truth table of one bit and two bit comparator using logic gates</li> </ol>						

### Mapping of Course Outcomes (CO's) with PO's & PSO's

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	1	0	1	0	0	0	0	0	0	2	2	1	1
<b>CO2</b>	3	3	3	2	3	2	1	0	1	2	1	2	3	2	1
<b>CO3</b>	3	3	3	2	2	2	2	1	1	2	0	0	2	0	2
<b>CO4</b>	3	2	3	2	3	2	2	1	0	0	1	1	2	2	2
<b>CO5</b>	3	3	3	2	3	2	2	2	1	1	2	2	3	0	2

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>			<b>BTAR</b>
<b>Course Code</b>	<b>25BTAR232</b>	<b>Number of Hours/Week</b>			<b>2</b>
<b>Semester</b>	<b>III</b>	<b>Max. Marks</b>			<b>100</b>
<b>Year</b>	<b>II</b>	<b>Credits</b>			<b>1</b>
<b>Core Course</b>					
<b>Course Title</b>	<b>DATA STRUCTURE AND ALGORITHMS LAB</b>			<b>L</b>	<b>T</b>
				<b>0</b>	<b>0</b>
<b>L-Lecture Hours</b>	<b>T-Tutorial Hours</b>	<b>P-Practical Hours</b>			
<b>COURSE OBJECTIVES:</b>					
<ul style="list-style-type: none"> <li>• To implement basic data structures like arrays linked lists, stacks, and queues.</li> <li>• To develop skills in implementing algorithms for searching and sorting.</li> <li>• To gain hands-on experience with tree and graph data structures.</li> <li>• To apply recursion and dynamic memory management in problem-solving.</li> <li>• To understand the practical implications of algorithm efficiency and optimization.</li> </ul>					
<b>Programs:</b>					
<ol style="list-style-type: none"> <li>1. Program for Insertion sort.</li> <li>2. Program for Quick sort.</li> <li>3. Program for Merge sort.</li> <li>4. Program for Heap sort.</li> <li>5. Implementation of a stack using an array with push and pop operations.</li> <li>6. Implementation of swap () function using stack.</li> <li>7. Implementation of swap () function using queue.</li> <li>8. Singly linked list with basic operations.</li> <li>9. Double linked list with basic operations.</li> <li>10. Hash table using direct addressing.</li> <li>11. Hash table using indirect addressing.</li> <li>12. Binary search tree with insertion and traversal.</li> <li>13. Graphs             <ol style="list-style-type: none"> <li>a. Depth First Search (DFS)</li> <li>b. Breadth First Search (BFS)</li> <li>c. Dijkstra's Algorithm (Shortest Path in Weighted Graph)</li> <li>d. Kruskal's Algorithm (Minimum Spanning Tree)</li> </ol> </li> <li>14. Tree Algorithms             <ol style="list-style-type: none"> <li>a. Binary Search Tree (BST) Operations</li> <li>b. AVL Tree (Balanced BST) Insertions</li> </ol> </li> <li>15. Verifying a Solution for the Knapsack Problem.</li> </ol>					

### Course Outcomes:

By learning Data Structures and Algorithms, students will be able to

CO1 : Demonstrate the implementation of basic data structures in real-world problems.

CO2 : Apply various searching and sorting techniques in practical scenarios.

CO3 : Implement tree and graph algorithms effectively.

CO4 : Solve complex problems using recursion and dynamic memory management.

CO5 : Analyze and optimize algorithms for better performance in practical applications.

### Mapping of Course Outcomes (CO's) with PO's & PSO's

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	0	2	3	1	0	2	1	1	0	2	2	2	0
<b>CO2</b>	3	3	2	2	3	1	0	2	1	2	1	2	2	3	3
<b>CO3</b>	3	3	3	3	2	1	1	2	2	1	1	3	2	3	3
<b>CO4</b>	2	3	3	3	3	2	2	3	2	2	2	3	3	3	3
<b>CO5</b>	2	3	3	3	3	2	2	3	2	2	2	3	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR233</b>	<b>Number of Hours/Week</b>	<b>2</b>			
<b>Semester</b>	<b>III</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>1</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>OBJECT ORIENTED PROGRAMMING WITH JAVA LAB</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>0</b>	<b>0</b>	<b>2</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students for:</b>						
<ul style="list-style-type: none"> <li>• To introduce the fundamentals of Java programming language.</li> <li>• To enable students to write object-oriented programs.</li> <li>• To familiarize students with advanced Java concepts like multithreading, exception handling, and collections.</li> <li>• To provide hands-on experience in developing real-world applications using Java.</li> </ul>						
<b>PROGRAMS</b>						
<ol style="list-style-type: none"> <li>1. Write a Java program to calculate the factorial of a number using loops.</li> <li>2. Implement a program to demonstrate the use of arrays and string operations (reverse, concatenate, length).</li> <li>3. Create a program to find the largest and smallest numbers in an array.</li> <li>4. Create a class Student with properties name, rollNumber, and marks. Write methods to calculate and display the grade.</li> <li>5. Demonstrate single and multilevel inheritance using classes for Shape, Rectangle, and Square.</li> <li>6. Implement polymorphism using method overloading and method overriding.</li> <li>7. Write a program to handle ArrayIndexOutOfBoundsException and NumberFormatException.</li> <li>8. Create a multithreaded program to calculate the sum of odd and even numbers in an array using two threads.</li> <li>9. Demonstrate thread synchronization by simulating a producer-consumer problem.</li> <li>10. Write a program to copy the contents of one text file to another using FileReader and FileWriter.</li> <li>11. Implement a program to serialize and deserialize an object of a class Employee.</li> <li>12. Create a program to count the number of words and characters in a text file.</li> <li>13. Create a simple calculator using AWT/Swing with basic arithmetic operations.</li> <li>14. Develop a GUI application to accept student details and display them in a table format.</li> <li>15. Create a Java Swing application to simulate a login screen with username and password validation.</li> </ol>						

# **Semester IV**

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR141</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>IV</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>Robotics</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>COURSE OBJECTIVES:</b>						
The main learning objective of this course is to prepare the students for:						
<ul style="list-style-type: none"> <li>• Introduce the basics of robotics, including robot definition, history, laws of robotics, and robot anatomy.</li> <li>• Provide an understanding of sensors and actuators in robotics, focusing on measurement systems and various types of sensors and actuators.</li> <li>• Explain robot drive mechanisms, including control systems, drive types, and components like lead screws, gear drives, and precision gearboxes.</li> <li>• Teach robot programming, including software functions, coordinate systems, position control, and flowcharting for robot programs.</li> <li>• Explore diverse robotics applications, including space, underwater, electric mobility, logistics, security, and agricultural robotics.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>INTRODUCTION:</b> Robot definition, Robotics and programmable automation Historical background, laws of Robotics. Robotics systems and Robot anatomy, specification of Robots. Robot geometrical configuration.				<b>9</b>	
<b>II</b>	<b>SENSORS AND ACTUATORS IN ROBOTICS:</b> Manipulator Measurement systems, sequential controllers & electric position sensors- limit switches- photoelectric sensors- proximity sensors- Inductive, capacitive, Magnetic sensors, pneumatic limit valve - electric actuators- Linear solenoids-linear induction motors- Rotary- stepper motors.				<b>9</b>	
<b>III</b>	<b>ROBOT DRIVE MECHANISM:</b> Objectives, motivation, open loop control, closed loop control with velocity and position feedback, Types of drive systems. Functions of drive system. Lead Screws, Ball Screws, Chain & linkage drives, Belt drives, Gear drives, Precision gear boxes, Harmonic drives, Cyclo speed reducers.				<b>9</b>	
<b>IV</b>	<b>ROBOT PROGRAMMING:</b> Robot software functions - coordinate systems, position control, other control functions, subroutines, Program planning for Robot flow charting for robot programs with few examples.				<b>9</b>	
<b>V</b>	<b>ROBOTICS APPLICATION:</b> Space Robotics- Underwater Robotics Electric Mobility - Logistics, Production and Consumer (LPC) - Search and Rescue (SAR) & Security Robotics - Assistance and Rehabilitation Systems- Agricultural Robotics				<b>9</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1** : Understand the basics of Robots

**CO2** : Elaborate the function of different sensors and actuators in the Robot

**CO3** : Understand the concepts of Robot Drive Mechanism

**CO4** : Write program to use robot for a typical application

**CO5** : Manipulate robots in different applications

## **Text Books:**

1. Saha, S.k "Introduction to Robotics,2nd Edition,McGraw-Hill Higher Education,New Delhi,2014.
2. Ghosal,A,"Robotics",Oxford,New Delhi,2006

## **Reference Books:**

1. P.A. Janaki Raman, Robotics and Image Processing an Introduction, Tata Mc Graw Hill Publishing company Ltd., 1995.
2. Francis N. Nagy, Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987
3. Paul W Chapman, "Smart Sensors", an Independent Learning Module Series, 1996
4. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, 'Industrial Robotics Technology, Programming and Applications', Mc Graw Hill Book company, 1986
5. Bernard Hodges, 'Industrial Robotics', Second Edition, Jaico Publishing House, 1993

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	3	2	2	3	2	1	2	2	2	3	3	3	3
<b>CO2</b>	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3
<b>CO3</b>	3	3	3	3	2	3	3	3	2	3	3	3	3	2	3
<b>CO4</b>	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
<b>CO5</b>	3	3	3	3	2	3	3	2	2	3	3	3	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE-(AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR241</b>	<b>Number of Hours/WK</b>	<b>2</b>			
<b>Semester</b>	<b>IV</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Part</b>		<b>Credit</b>	<b>1</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>ROBOTICS LABORATORY</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>0</b>	<b>0</b>	<b>2</b>

### List of experiments:

Part A: Interfacing sensors and actuators
<ol style="list-style-type: none"> <li>1. Familiarisation of Arduino IDE,Arduino microcontroller I/O interfacing( LED, LCD,Serial Monitor)</li> <li>2. Interfacing IR and Ultrasonic sensor with Arduino</li> <li>3. Interfacing DC motors with arduino - speed and direction control</li> <li>4. Interfacing Servo Motors with Arduino - angle of rotation</li> <li>5. Calibration of sensors-sonar, IR sensors and obtain the calibration curve</li> <li>6. Mobile Robot assembly</li> <li>7. Networking with Arduino: GSM and Bluetooth</li> </ol>
Part B: Intelligent systems
<ol style="list-style-type: none"> <li>8. Writing a Simple Publisher and Subscriber, Simple Service and Client,Recording and playing back data, Reading messages from a bag file(Python/C++)</li> <li>9. Localization of a mobile robot using LIDAR (ROS)</li> <li>10. Touch Sensors interfacing and feedback system</li> <li>11. Line following Robot using IR sensor</li> <li>12. Obstacle avoidance of a mobile robot while moving to a point.</li> <li>13. Object detection using any one standard algorithm</li> <li>14. Navigation simulation using turtlebot using ROS</li> </ol>

### Course outcome:

On successful completion of this course, the student will be able to

- CO1:** Interface different peripherals to Arduino board
- CO2:** Assemble a mobile robot with different sensors and actuators...
- CO3:** Familiarize about localization of mobile robots
- CO4:** Impart intelligence to robot using standard algorithms.
- CO5:** Familiarize the robot navigation

### Mapping of Course Outcomes (CO's) with PO's & PSO's

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	0	1	1	0	0	0	2	0	0	0	1	3	2	0	0
<b>CO2</b>	3	3	0	2	3	0	0	0	0	0	1	3	2	0	0
<b>CO3</b>	3	3	3	2	2	0	0	0	0	0	3	3	2	1	1
<b>CO4</b>	2	3	1	3	2	0	0	0	0	0	1	3	2	1	1
<b>CO5</b>	3	3	2	3	3	0	0	0	0	0	1	3	2	1	1

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR142</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>IV</b>	<b>Max. Marks</b>	100			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>DATABASE MANAGEMENT SYSTEMS</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours</b>	<b>T-Tutorial Hours</b>	<b>P-Practical Hours</b>				
<b>COURSE OBJECTIVES:</b>						
The main learning objective of this course is to prepare the students for:						
<ul style="list-style-type: none"> <li>● To learn data models, conceptualize and depict a database system using ER diagram</li> <li>● To understand the internal storage structures in a physical DB design</li> <li>● To know the fundamental concepts of transaction processing techniques</li> <li>● To understand the concept of Database Design in Normalization techniques</li> <li>● To know the manipulation of SQL Queries</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Unit I</b> Data base System Applications, Purpose of Database Systems, View of Data, Data Abstraction, Instances and Schemas, data Models , the ER Model , Relational Model , Other Models , Database Languages , DDL , DML , database Access for applications Programs, data base Users and Administrator , Transaction Management , data base Architecture, Storage Manager , the Query Processor Data base design and ER diagrams , ER Model, Entities, Attributes and Entity sets , Relationships and Relationship sets , ER Design Issues, Concept Design , Conceptual Design for University Enterprise. Introduction to the Relational Model, Structure, Database Schema, Keys, Schema Diagrams.				<b>9</b>	
<b>II</b>	<b>Unit II</b> Relational Query Languages, Relational Operations. Relational Algebra, Selection and projection set operations, renaming , Joins , Division , Examples of Algebra overviews , Relational calculus , Tuple relational Calculus , Domain relational calculus. Overview of the SQL Query Language, Basic Structure of SQL Queries, Set Operations, Aggregate Functions , GROUPBY , HAVING, Nested Sub queries, Views, Triggers.				<b>9</b>	
<b>III</b>	<b>Unit III</b> Normalization, Introduction, Non loss decomposition and functional dependencies, First, Second, and third normal forms , dependency preservation, Boyee/Codd normal form. Higher Normal Forms ,Introduction, Multi,valued dependencies and Fourth normal form, Join dependencies and Fifth normal form				<b>9</b>	

<b>IV</b>	Transaction State, Implementation of Atomicity and Durability, Concurrent, Executions, Serializability, Recoverability , Implementation of Isolation , Testing for serializability, Lock ,Based Protocols , Timestamp Based Protocols, Validation, Based Protocols , Multiple Granularity. Recovery and Atomicity, Log Based Recovery , Recovery with Concurrent Transactions , Buffer Management , Failure with loss of nonvolatile storage, Advance Recovery systems, Remote Backup systems.	<b>9</b>
<b>V</b>	File organization, various kinds of indexes. Query Processing, Measures of query cost , Selection operation , Projection operation, , Join operation , set operation and aggregate operation , Relational Query Optimization , Transacting SQL queries , Estimating the cost , Equivalence Rules.	<b>9</b>

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1:** Install, configure, and interact with a relational database management system

**CO2:** Master the basics of SQL and construct queries using SQL

**CO3:** Design and develop a large database with optimal query processing

**CO4:** Develop efficient storage scheme of saving and retrieving Records and Files

**CO5:** Design the database with normalization techniques

### **Text Books**

1. “Data base System Concepts”, Silberschatz, Korth, McGraw hill, Sixth Edition, 2010
2. “Data base Management Systems” , Raghurama Krishnan, Johannes Gehrke, TATA McGrawHill Third Edition, 2003

### **Reference Books**

1. “Fundamentals of Database Systems”, Elmasri Navathe Pearson Education, 2015
2. “An Introduction to Database systems”, C.J. Date, A.Kannan, S.Swami Nadhan, Pearson, Eight Edition, 2019.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	0	2	2	0	0	0	0	0	0	0	0	0	0	2
<b>CO2</b>	2	2	0	0	0	0	0	0	0	0	0	0	1	1	3
<b>CO3</b>	2	0	3	3	2	3	0	1	2	0	2	1	0	0	3
<b>CO4</b>	2	2	2	2	2	3	0	1	2	0	2	1	2	0	1
<b>CO5</b>	0	0	0	2	1	1	1	1	1	1	2	1	1	0	2

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>
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<b>Course Code</b>	<b>25BTAR242</b>	<b>Number of Hours/Week</b>	<b>2</b>		
<b>Semester</b>	<b>IV</b>	<b>Max. Marks</b>	<b>100</b>		
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>1</b>		
<b>Core Course</b>					
<b>Course Title</b>	<b>DATABASE MANAGEMENT SYSTEMS LAB</b>		<b>L</b>	<b>T</b>	<b>P</b>
			<b>0</b>	<b>0</b>	<b>2</b>
<b>L-Lecture Hours</b>	<b>T-Tutorial Hours</b>	<b>P-Practical Hours</b>			
<b>COURSE OBJECTIVES:</b>					
The main learning objective of this course is to prepare the students for:					
<ul style="list-style-type: none"> <li>● Understand and Apply SQL DDL and DML Commands</li> <li>● Utilize SQL Functions and Operators Effectively</li> <li>● Implement SQL Joins and Advanced Clauses</li> <li>● Work with Constraints, Views, and Subqueries in SQL</li> <li>● Master Database Management and PL/SQL Concepts</li> </ul>					
<b><u>Programs</u></b>					
<ol style="list-style-type: none"> <li>1. DDL commands of SQL with suitable examples <ul style="list-style-type: none"> <li>Create table</li> <li>Alter table</li> <li>Drop Table</li> </ul> </li> <li>2. DML commands of SQL with suitable examples <ul style="list-style-type: none"> <li>Insert</li> <li>Update</li> <li>Delete</li> </ul> </li> <li>3. Different types of function with suitable examples <ul style="list-style-type: none"> <li>Number function</li> <li>Aggregate Function</li> <li>Character Function</li> <li>Conversion Function</li> <li>Date Function</li> </ul> </li> <li>4. Different types of operators in SQL <ul style="list-style-type: none"> <li>Arithmetic Operators</li> <li>Logical Operators</li> <li>Comparison Operator</li> <li>Special Operator</li> <li>Set Operation</li> </ul> </li> <li>5. Different types of Joins <ul style="list-style-type: none"> <li>Inner Join</li> <li>Outer Join</li> <li>Natural Join etc..</li> </ul> </li> </ol>					

6. Study and Implementation of  
Group By & having clause  
Order by clause  
Indexing
7. Study & Implementation of Sub  
queries  
Views
8. Different types of constraints
9. Database Backup & Recovery commands.  
Rollback, Commit, Savepoint.
10. Creating Database /Table Space Managing  
Users: Create User, Delete User  
Managing roles:-Grant, Revoke
11. PL/SQL
12. SQL Triggers

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

- CO1:** Understand and apply SQL Data Definition Language (DDL) commands.
- CO2:** Understand and execute SQL Data Manipulation Language (DML) commands.
- CO3:** Apply different SQL functions to manipulate and retrieve data.
- CO4:** Understand and apply different types of constraints in SQL.
- CO5:** Design and implement SQL triggers for automated actions.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	0	2	2	0	0	0	0	0	0	0	0	0	0	2
<b>CO2</b>	2	2	0	0	0	0	0	0	0	0	0	0	1	1	3
<b>CO3</b>	2	0	3	3	2	3	0	1	2	0	2	1	0	0	3
<b>CO4</b>	2	2	2	2	2	3	0	1	2	0	2	1	2	0	1
<b>CO5</b>	0	0	0	2	1	1	1	1	1	1	2	1	1	0	2

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech. CSE- (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>		
<b>Course Code</b>	<b>25BTAR143</b>	<b>Number of Hours/Week</b>	<b>3</b>		
<b>Semester</b>	<b>IV</b>	<b>Max. Marks</b>	<b>100</b>		
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>		
<b>Core Course</b>					
<b>Course Title</b>	<b>COMPUTER ORGANIZATION AND ARCHITECTURE</b>	<b>L</b>	<b>T</b>	<b>P</b>	
		<b>3</b>	<b>0</b>	<b>0</b>	
<b>COURSE OBJECTIVES:</b>					
The main learning objective of this course is to prepare the students:					
<ul style="list-style-type: none"> <li>• To understand the architecture and basic components of a computer system.</li> <li>• To learn data representation and perform arithmetic operations.</li> <li>• To study control unit design and high-performance processor concepts.</li> <li>• To explore memory systems and storage technologies.</li> <li>• To examine I/O interfacing, communication, and bus systems.</li> </ul>					
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>
<b>I</b>	<b>Fundamentals of Computer Architecture and Organization</b> Overview of Organization vs. Architecture - Functional components: Registers, Register files, Interconnection of components - IAS computer function, von Neumann & Harvard architectures - CISC vs. RISC architectures - Introduction to Instruction Sets - Instruction Set Architecture (ISA), instruction formats, instruction set categories - Addressing modes - Phases of instruction cycle				<b>9</b>
<b>II</b>	<b>Data Representation and Arithmetic Operations</b> Representation of data: Binary, Hex, Character codes - Fixed-point arithmetic: Booth's Algorithm, Modified Booth's; Restoring and Non-restoring Division - Floating-point arithmetic: Addition, Subtraction, Multiplication, Division - ALU concepts - Performance Metrics: Execution time, MIPS, MFLOPS				<b>9</b>
<b>III</b>	<b>Control Unit and High Performance Processors</b> Datapath and Control Unit: Hardwired Control; Microprogrammed Control - Pipelining: Two-stage, Multi-stage - Hazards: Structural, Data, Control - Hazard resolution techniques and limitations - Branch handling techniques - Flynn's taxonomy (SISD, SIMD, MISD, MIMD) - Superscalar and Super pipeline architectures - Amdahl's Law, Speed-up and Efficiency				<b>9</b>
<b>IV</b>	<b>Memory System Organization and Storage Subsystems</b> Memory hierarchy & types - Byte storage methods, conceptual view of memory cells - RAM and ROM, scalable memory design - Cache memory: Mapping techniques, Replacement policies, Management techniques, Mean access time evaluation - Memory Interleaving and Address mapping - External Storage: SSDs, Disk structure - RAID levels, ECC (Error detection & correction) - Reliability of memory systems				<b>9</b>
<b>V</b>	<b>Interfacing, Communication and I/O Systems</b> I/O Fundamentals: Handshaking, Buffering, I/O Modules - I/O Techniques: Programmed I/O, Interrupt-driven I/O, Direct Memory Access (DMA), Direct Cache Access - Interrupt structures: Vectored, Prioritized - Bus systems: Synchronous & Asynchronous - Bus Arbitration Techniques - I/O Performance considerations				<b>9</b>

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1 :** Describe computer architecture, organization, and instruction formats

**CO2 :** Perform binary, fixed-point, and floating-point arithmetic operations.

**CO3:** Explain control unit design, pipelining, and parallel architectures

**CO4 :** Analyze memory hierarchy, cache systems, and storage reliability

**CO5 :** Evaluate I/O techniques, bus structures, and interfacing methods

## **Text Books:**

1. David A. Patterson and John L. Hennessy, Computer Organization and Design – The Hardware / Software Interface, 6th Edition, Morgan Kaufmann, 2020.

## **ReferenceBooks:**

1. Computer Architecture and Organization – Designing for Performance, William Stallings, 11<sup>th</sup> Edition, Pearson Education Series, 2022.
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer Organization, McGraw Hill, Fifth Edition, Reprint 2011.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	0	2	3	1	0	2	1	1	0	2	2	2	0
<b>CO2</b>	3	3	2	2	3	1	0	2	1	2	1	2	2	3	2
<b>CO3</b>	3	3	3	3	2	1	1	2	2	1	1	3	2	3	3
<b>CO4</b>	2	3	3	3	3	2	2	3	2	2	2	3	3	3	3
<b>CO5</b>	2	3	3	3	3	2	2	3	2	2	2	3	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR341</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>IV (DSE I)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>OPERATING SYSTEMS</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To explore fundamental concepts in operating system</li> <li>• To understand essential functions of operating system</li> <li>• To equip process synchronization problems in real life applications</li> <li>• To acquire memory and file management concepts in operating system.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to Operating System</b> Introduction, operating system operations, process management, memory management, storage management, protection and security, distributed systems, Operating system services and systems calls, system programs, operating system structure, operating systems generations.				<b>9</b>	
<b>II</b>	<b>Process Management and Concurrency</b> Process concepts, process state, process control block, scheduling queues, process scheduling, multithreaded programming, threads in UNIX, comparison of UNIX and windows, Process synchronization, critical section problem, Peterson's solution, synchronization hardware, semaphores, classic problems of synchronization, readers and writers problem, dining philosophers problem, monitors.				<b>9</b>	
<b>III</b>	<b>Deadlocks and Memory Management</b> System model, deadlock characterization, deadlock prevention, detection and avoidance, recovery from deadlock banker's algorithm. Swapping, contiguous memory allocation, paging, structure of the page table, segmentation, virtual memory, demand paging, page-replacement algorithms, allocation of frames, thrashing				<b>9</b>	
<b>IV</b>	<b>File System</b> Concept of a file, access methods, directory structure, file system mounting, file sharing, protection. File system implementation: file system structure, file system implementation, directory implementation, allocation methods, free-space management, efficiency and performance				<b>9</b>	
<b>V</b>	<b>I/O System</b> Mass storage structure - overview of mass storage structure, disk structure, disk attachment, disk scheduling algorithms, swap space management, stable storage implementation, tertiary storage structure. I/O: Hardware, application I/O interface, kernel I/O subsystem, transforming I/O requests to hardware operations, streams, performance.				<b>9</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Differentiate basic functionalities in operating system
<b>CO2</b>	Solve process synchronization and scheduling problems
<b>CO3</b>	Implement mutual exclusion principles in real applications
<b>CO4</b>	Develop system model to handle deadlock situations
<b>CO5</b>	Design file and I/O system to improve performance

## **Text Books:**

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles, 9th edition, Wiley India Private Limited, New Delhi, 2012.

## **Reference Books:**

1. Andrew S. Tanenbaum, Herbert Bos, Modern Operating Systems, 4th edition, Prentice Hall of India, India, 2016.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	0	1	0	0	1	2	3	0	1	0	2	2	0	2
CO2	3	3	2	3	2	2	2	0	0	2	0	2	0	0	2
CO3	3	3	3	2	2	1	2	0	0	2	0	2	0	0	2
CO4	3	2	3	2	1	2	2	0	0	2	0	2	1	0	2
CO5	2	2	3	3	1	0	2	0	0	2	2	2	1	0	2

high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR342</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>IV (DSE I)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>DATA MINING AND DATA WAREHOUSING</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To understanding of data warehousing, data mining, and advanced analytics techniques essential for effective business decision-making.</li> <li>• To learn how to build, manage, and utilize data warehouses and apply various data mining techniques for insightful analysis.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Data Warehousing and Business Analysis:</b> Data warehousing Components –Building a Data warehouse –Data Warehouse Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata –reporting – Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis				<b>9</b>	
<b>II</b>	<b>Data Mining:</b> Data Mining Functionalities – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation- Architecture Of A Typical Data Mining Systems- Classification Of Data Mining Systems				<b>9</b>	
<b>III</b>	<b>Association Rule Mining:</b> Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining				<b>9</b>	
<b>IV</b>	<b>Classification and Prediction:</b> Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section				<b>9</b>	
<b>V</b>	<b>Cluster Analysis:</b> Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis				<b>9</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Understand Data Warehousing Concepts.
<b>CO2</b>	Apply data extraction, cleanup, and transformation tools effectively and utilize metadata in reporting and querying applications.
<b>CO3</b>	Analyze Data Using OLAP and Create and interpret reports that utilize OLAP Capabilities.
<b>CO4</b>	Apply Data Mining Techniques and explain the functionalities of data mining and the processes of data preprocessing, cleaning, integration, and transformation.
<b>CO5</b>	Evaluate Data Analysis Techniques and assess the accuracy of classifiers and predictors through appropriate evaluation metrics. Utilize ensemble methods for improved prediction accuracy.

## **Text Book:**

1. Jiawei Han, Micheline Kamber and Jian Pei “Data Mining Concepts and Techniques”, Third Edition, Elsevier, 2011

## **Reference Books**

1. Alex Berson and Stephen J. Smith “Data Warehousing, Data Mining & OLAP”, Tata McGraw – Hill Edition, Tenth Reprint 2007.
2. K.P. Soman, Shyam Diwakar and V. Ajay “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006.
3. G. K. Gupta “Introduction to Data Mining with Case Studies”, 3<sup>rd</sup> Edition, Prentice Hall of India, 2014.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	3	1	2	1	3	2	2	1	2	1	3
CO2	3	2	3	2	3	1	2	1	3	3	3	2	2	1	3
CO3	3	3	3	2	3	2	3	1	3	2	2	2	2	1	3
CO4	3	3	3	2	3	2	2	1	3	3	3	2	3	1	3
CO5	3	3	3	2	3	3	2	1	3	3	3	2	3	2	3

high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR343</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>IV (DSE I)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>SOCIAL NETWORK ANALYSIS</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students to:</b>						
<ul style="list-style-type: none"> <li>• Explain the evolution of the Semantic Web, its limitations, and the role of social web platforms in network analysis.</li> <li>• Apply ontology-based knowledge representation and advanced modelling techniques to social network data.</li> <li>• Analyse and extract insights from web communities and study their evolution using archival data.</li> <li>• Evaluate human behaviour in social networks and address privacy, trust, and reputation challenges.</li> <li>• Utilize visualization techniques and graph theory to analyse and interpret social networks in practical scenarios.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>INTRODUCTION</b> Introduction to Semantic Web: Limitations of current Web – Development of Semantic Web. Emergence of the Social Web – Social Network analysis: Development of Social Network. Analysis – Key concepts and measures in network analysis – Electronic sources for network.				<b>9</b>	
<b>II</b>	<b>MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION</b> Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Language – Modelling and aggregating social network data: State-of-the-art in network data. social relationships – Aggregating and reasoning with social network data – Advanced. Representations.				<b>9</b>	
<b>III</b>	<b>EXTRACTION AND MINING COMMUNITIES IN WEB SOCIAL NETWORKS:</b> Extracting evolution of Web Community from a Series of Web Archive – Detecting.				<b>9</b>	
<b>IV</b>	<b>VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS</b> Graph theory – Centrality – Clustering – Node-Edge Diagrams – Matrix representation – Visualizing online social networks, visualizing social networks with matrix-based. representations – Matrix and Node-Link Diagrams – Hybrid representations – Applications – Cover networks – Community welfare – Collaboration networks – Co-Citation networks.				<b>9</b>	

<b>V</b>	<p><b>PREDICTING HUMAN BEHAVIOR AND PRIVACY ISSUES</b>  Understanding and predicting human behaviour for social communities – User data management.– Inference and Distribution – Enabling new human experiences – Reality mining – Context – Awareness – Privacy in online social networks – Trust in online environment – Trust models based on subjective logic – Trust network analysis – Trust transitivity analysis – Combining Trust and reputation – Trust derivation based on trust comparisons.</p>	<b>9</b>
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**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Illustrate the Evolution of the Semantic Web and Social Web Platforms
<b>CO2</b>	Apply Ontology-Based Knowledge Representation and Modeling Techniques
<b>CO3</b>	Extract Insights from Web Communities and Evaluate Evolution
<b>CO4</b>	Assess Human Behavior and Address Privacy, Trust, and Reputation Challenges
<b>CO5</b>	Employ Graph Theory and Visualization Techniques for Social Network Analysis

**Text Books:**

1. **Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL, Authors:** Dean Allemang, James Hendle, **Publisher:** Morgan Kaufmann, **Edition:** 2nd Edition (2011)

**Reference Books:**

1. **The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management, Authors:** Tim Berners-Lee, James Hendler, Ora Lassila, **Publisher:** Morgan Kaufmann, **Edition:** 1st Edition (2001)

**Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	2	3	2	2	1	1	2	1	2
CO2	3	3	3	2	3	2	2	2	3	3	2	2	3	3	3
CO3	2	3	3	3	3	2	2	2	3	3	2	2	3	3	3
CO4	3	2	2	3	2	2	3	3	2	3	2	3	3	2	2
CO5	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3

high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR344</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>IV (DSE II)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>FULL STACK DEVELOPMENT</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To understand the various components of full stack development</li> <li>• To learn Node.js features and applications</li> <li>• To develop applications with MongoDB</li> <li>• To understand the role of Angular and Express in web applications</li> <li>• To develop simple web applications with React</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Basics Of Full Stack:</b> Understanding the Basic Web Development Framework – User – Browser – Webserver – Backend Services – MVC Architecture – Understanding the different stacks –The role of Express – Angular – Node – Mongo DB – React				<b>9</b>	
<b>II</b>	<b>Node JS:</b> Basics of Node JS – Installation – Working with Node packages – Using Node package manager – Creating a simple Node.js application – Using Events – Listeners –Timers – Call backs – Handling Data I/O – Implementing HTTP services in Node.js				<b>9</b>	
<b>III</b>	<b>Mongo DB:</b> Understanding NoSQL and MongoDB – Building MongoDB Environment – User accounts – Access control – Administering databases – Managing collections – Connecting to MongoDB from Node.js – simple applications				<b>9</b>	
<b>IV</b>	<b>Express And Angular:</b> Implementing Express in Node.js – Configuring routes – Using Request and Response objects Angular – Typescript – Angular Components – Expressions – Data binding – Built-in directives				<b>9</b>	
<b>V</b>	<b>React:</b> MERN STACK – Basic React applications – React Components – React State – Express REST APIs – Modularization and Web pack – Routing with React Router – Server-side rendering				<b>9</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Understanding of full-stack development, including front-end, back-end, and database integration using popular technologies.
<b>CO2</b>	Develop practical knowledge of Node.js, including installation, using npm, creating applications, and handling asynchronous operations with events, callbacks, and timers.
<b>CO3</b>	Master MongoDB and NoSQL concepts, from database setup to collection management, and connecting MongoDB with Node.js applications.
<b>CO4</b>	Learn how to build dynamic web applications using Angular, including components, directives, data binding, and Typescript.
<b>CO5</b>	Acquire hands-on experience with the MERN stack to build full-stack applications with React, Express, and REST APIs, including routing and server-side rendering.

## **Text Book:**

1. Brad Dayley, Brendan Dayley, Caleb Dayley, 'Node.js, MongoDB and Angular Web Development', Addison-Wesley, Second Edition, 2018
2. Vasan Subramanian, 'Pro MERN Stack, Full Stack Web App Development with Mongo, Express, React, and Node', Second Edition, Apress, 2019.

## **Reference Books**

1. Full-Stack JavaScript Development by Eric Bush.
2. Mastering Full Stack React Web Development Paperback – April 28, 2017 by Tomasz Dyl, Kamil Przeorski, Maciej Czarnecki
3. Chris Northwood, 'The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer', Apress; 1st edition, 2018
4. Kirupa Chinnathambi, 'Learning React: A Hands-On Guide to Building Web Applications Using React and Redux', Addison-Wesley Professional, 2nd edition, 2018

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	3	1	2	1	3	2	2	1	2	1	3
CO2	3	2	3	2	3	1	2	1	3	3	3	2	2	1	3
CO3	3	3	3	2	3	2	3	1	3	2	2	2	2	1	3
CO4	3	3	3	2	3	2	2	1	3	3	3	2	3	1	3
CO5	3	3	3	2	3	3	2	1	3	3	3	2	3	2	3

3 - high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR345</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>IV (DSE II)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>EDGE AI</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students to:</b>						
<ul style="list-style-type: none"> <li>• Understand the fundamentals of AI and its execution on edge devices.</li> <li>• Learn the principles and workflows of TinyML development.</li> <li>• Explore hardware and software platforms used in Edge AI applications.</li> <li>• Analyze model optimization techniques for deploying ML models on constrained devices.</li> <li>• Implement real-time ML applications using microcontrollers and sensors.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to Edge AI and TinyML:</b> Edge AI – Need for on-device intelligence – Applications of Edge AI – TinyML – TinyML vs Traditional ML – Key constraints (power, memory, latency) – Overview of Edge AI pipeline				<b>9</b>	
<b>II</b>	<b>ML Workflow and Model Building for Edge:</b> Dataset collection – Data preprocessing – Feature engineering – Model training and evaluation – ML algorithms for Edge: Decision Trees, SVM, kNN, Tiny Neural Networks				<b>9</b>	
<b>III</b>	<b>Hardware and Software Platforms:</b> Microcontrollers (Arduino, STM32, ESP32) – Sensor interfacing – Operating systems (FreeRTOS, TFLite Micro) – Toolchains (Edge Impulse, TensorFlow Lite, CMSIS-NN) – Edge deployment lifecycle				<b>9</b>	
<b>IV</b>	<b>Model Optimization and Deployment:</b> Quantization, Pruning, Knowledge Distillation – Memory and compute optimization – Converting models to TFLite – Deployment using Arduino IDE, TFLite Micro runtime				<b>9</b>	
<b>V</b>	<b>Applications and Case Studies:</b> Real-time projects: keyword spotting, gesture recognition, vibration analysis – Integrating TinyML with IoT – Power management – Privacy and security in Edge AI				<b>9</b>	

## COURSE OUTCOMES:

On successful completion of this course, the student will be able to:

<b>CO1</b>	Explain the basics of Edge AI and the need for TinyML.
<b>CO2</b>	Apply machine learning workflows to develop small-scale models.
<b>CO3</b>	Compare edge hardware platforms and deployment pipelines.
<b>CO4</b>	Use model compression and optimization for resource-constrained devices.
<b>CO5</b>	Build and test TinyML applications using real-world sensors and microcontrollers.

## Text Book

1. **Pete Warden & Daniel Situnayake**, *TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers*, O'Reilly, 2020.
2. **Ajit Jaokar**, *AI on the Edge: Powerful Machine Learning on Tiny Devices*, Packt Publishing, 2021.

## Reference Books

1. Laurence Moroney, *AI and Machine Learning for On-Device Development*, O'Reilly, 2021.
2. Arm Education, *Machine Learning on Arm Cortex-M Microcontrollers*, Arm Education Media, 2021.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	2	3	2	2	3	2	2	2	2	3
CO2	3	3	3	2	3	2	3	3	3	2	3	2	2	2	2
CO3	3	3	2	3	2	2	3	3	2	3	2	2	3	3	2
CO4	3	2	2	3	1	2	3	2	2	3	1	2	3	3	2
CO5	3	2	2	2	1	2	3	2	2	2	1	2	3	3	3

3 - high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>		
<b>Course Code</b>	<b>25BTAR346</b>	<b>Number of Hours/Week</b>	<b>3</b>		
<b>Semester</b>	<b>IV (DSE II)</b>	<b>Max. Marks</b>	<b>100</b>		
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>		
<b>Discipline Specific Elective</b>					
<b>Course Title</b>	<b>DESIGN AND ANALYSIS OF ALGORITHMS</b>	<b>L</b>	<b>T</b>	<b>P</b>	
		<b>3</b>	<b>0</b>	<b>0</b>	
<p><b>COURSE OBJECTIVES:</b></p> <p>The main learning objective of this course is to prepare the students for:</p> <ul style="list-style-type: none"> <li>• To prove correctness of algorithms</li> <li>• To analyse algorithms asymptotically</li> <li>• To demonstrate the efficiency of algorithms by using in existing problems</li> <li>• To utilize advanced algorithms and data structures in complex problems</li> </ul>					
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>
<b>I</b>	<b>Algorithm analysis and height balanced BST</b> Analysis of algorithms – introduction; solving recurrences – substitutions, recursion tree, and master method; binary search tree (BST) – insertion, deletion; BST applications – runway reservation; height balanced BSTs; AVL Tree – rotations, insertions, deletions;				<b>9</b>
<b>II</b>	<b>Divide and Conquer and Hashing</b> Interval or activity scheduling; Divide and Conquer approach – Strassen’s algorithm for matrix multiplication; randomized algorithms, median and order statistics, Hashing – direct address tables, hash tables, chaining; Hash function; Universal hashing; Open addressing – linear probing, quadratic probing and double hashing;				<b>9</b>
<b>III</b>	<b>Dynamic and Greedy algorithms</b> Dynamic and greedy algorithms, Matrix-chain multiplication, Longest common subsequence; Huffman codes; B Trees – searching, search, insertion, deletion; Data structures for disjoint sets – linked list representation, tree representation, union by rank and path compression;				<b>9</b>
<b>IV</b>	<b>Graph Algorithms</b> Graph algorithms – depth first search, breadth first search, topological sort, strongly connected components, Kruskal and Prim algorithm for minimum spanning tree; Single source shortest paths – Bellman-Ford algorithm, Single-source shortest path in directed acyclic graphs; Dijkstra’s algorithm;				<b>9</b>
<b>V</b>	<b>P and NP Problems</b> NP-Completeness – polynomial time, verification, NP-Completeness and reducibility, NP-Complete problems; Naïve string matching algorithm, Rabin-Karp algorithm;				<b>9</b>

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1 :** Write correctness proofs for algorithms

**CO2 :** Analyse asymptotic performance of algorithms

**CO3:** Implement efficient algorithms in engineering applications

**CO4 :** Demonstrate the familiarity with advanced algorithms and data structures

**CO5 :** Design algorithms in terms of asymptotic performance

## **Text Books:**

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to Algorithms, Third Edition. The MIT Press, 3rd edition, 2009

## **ReferenceBooks:**

1. Thomas H. Cormen. Algorithms Unlocked. The MIT Press, 2013
2. Ellis Horowitz, Sartaj Sahni, and SanguthevarRajasekaran. Fundamentals of Computer Algorithms (Computer software engineering series). Galgotia Publications, new edition edition, 2001

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	0	2	3	1	0	2	1	1	0	2	2	2	0
<b>CO2</b>	3	3	2	2	3	1	0	2	1	2	1	2	2	3	2
<b>CO3</b>	3	3	3	3	2	1	1	2	2	1	1	3	2	3	3
<b>CO4</b>	2	3	3	3	3	2	2	3	2	2	2	3	3	3	3
<b>CO5</b>	2	3	3	3	3	2	2	3	2	2	2	3	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI&amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR841</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>IV</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>II</b>	<b>Credits</b>	<b>3</b>			
<b>Skill Enhancement Course</b>						
<b>Course Title</b>	<b>ENGINEERING ECONOMICS &amp; FOREIGN TRADE</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours      T-Tutorial Hours      P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<ul style="list-style-type: none"> <li>• To understand basic economic principles relevant to engineering.</li> <li>• To analyze consumer and producer behavior using economic models.</li> <li>• To explore market structures and pricing mechanisms.</li> <li>• To apply cost estimation techniques in engineering decisions.</li> <li>• To gain awareness of foreign trade, globalization, and their impact.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction</b> The themes of economics – scarcity and efficiency – three fundamental economic problems – society’s capability – Production possibility frontiers (PPF) – Productive efficiency Vs economic efficiency – economic growth & stability – Micro economies and Macro economies – the role of markets and government – Positive Vs negative externalities.				<b>9</b>	
<b>II</b>	<b>Consumer and Producer Behaviour</b> Market – Demand and Supply – Determinants – Market equilibrium – elasticity of demand and supply – consumer behavior – consumer equilibrium – Approaches to consumer behavior – Production – Short-run and long-run Production Function – Returns to scale – economies Vs diseconomies of scale – Analysis of cost – Short- run and long-run cost function – Relation between Production and cost function				<b>9</b>	
<b>III</b>	<b>Product and Factor Market</b> Product market – perfect and imperfect market – different market structures – Firm’s equilibrium and supply – Market efficiency – Economic costs of imperfect competition – factor market – Land, Labour and capital – Demand and supply – determination of factor price – Interaction of product and factor market – General equilibrium and efficiency of competitive markets.				<b>9</b>	
<b>IV</b>	<b>Engineering Costs &amp; Estimation</b> Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model. Inflation, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis.				<b>9</b>	

<b>V</b>	<b>Foreign Trade</b> Introduction, Definition of Foreign Trade, balance of Trade, difference between international and domestic business, Advantages and Disadvantages of International Business, Globalization of Markets, Trends in Globalization, Effects and Benefits of Globalization, balance of payment and foreign exchange.	<b>9</b>
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### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>Course Outcomes</b>
<b>CO 1:</b> Understand the fundamental themes of economics
<b>CO 2:</b> Demonstrate market dynamics including demand and supply and their determinants.
<b>CO 3:</b> Appraise the firm equilibrium and supply in relation to market efficiency.
<b>CO 4:</b> Illustrate the different engineering cost concepts, including fixed, variable, and opportunity costs, and apply these concepts to perform break-even analysis.
<b>CO 5:</b> Evaluate the globalization trends, balance of payments and foreign exchange dynamics.

### **Textbook:**

1. Karl E. Case and Ray C. fair, Principles of Economics, 7th edition, Pearson, Education Asia, New Delhi, 2022.

### **Reference Books:**

1. Paul A. Samuelson, William D. Nordhaus, Sudip Chaudhuri and Anindya Sen, Economics, 19th edition, Tata McGraw Hill, New Delhi, 2021
2. William Boyes and Michael Melvin, Textbook of economics, Biztantra, 2022.
3. N. Gregory Mankiw, Principles of Economics, 8th edition, Thomson learning, New Delhi, 2021

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0
<b>CO2</b>	0	1	0	1	0	1	0	0	1	0	1	0	0	0	1
<b>CO3</b>	0	1	0	1	0	0	0	0	1	0	1	0	0	0	1
<b>CO4</b>	0	1	0	1	0	0	0	0	1	0	2	0	0	0	0
<b>CO5</b>	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0

3 – High, 2 – Average, 1 – Low , 0-Null

# **Semester V**

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR151</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>V</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>SENSORS AND ACTUATORS FOR ROBOTICS</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students to:</b>						
<ul style="list-style-type: none"> <li>• To analyze and summarize the different types of sensors, signal conditioning circuits, and actuators</li> <li>• To introduce students to the criteria for selecting a sensor for a specific measurement</li> <li>• To explain the types of actuators—electrical, pneumatic, and hydraulic—and their operation</li> <li>• To familiarize students with the basic principles of robotics and automation systems</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Basics of Energy Transformation:</b> Introduction to sensors and transducers, Principle of sensing and transduction, Classification of sensors.				<b>9</b>	
<b>II</b>	<b>Performance Characteristics of Sensors:</b> Static characteristics: accuracy, precision, resolution, sensitivity, linearity, span and range - Dynamic characteristics, Mathematical model of transducer: zero, first and second, Response to impulse, step, ramp and sinusoidal inputs, Selection criteria of sensor.				<b>9</b>	
<b>III</b>	<b>Actuator Performance and Selection :</b> Electrical actuating systems: solid-state switches, solenoids and electric motors: DC motor, stepper motor, and Inertial measurement unit, Mechanical actuating systems: types of motion, kinematic chains, cams and gears, Pneumatic and hydraulic actuating systems: diaphragms, bellows and control valves.				<b>9</b>	
<b>IV</b>	<b>Measurement of Industrial Parameters:</b> Measurement of temperature: thermistor and LM35, Measurement of pressure: strain gauge and piezoelectric type, Measurement of distance: ultrasonic, linear variable differential transformer and capacitance type, proximity sensor, Infrared sensor, Pulse oximeter and Tachometer. <b>Signal Conditioning</b> Amplification, Filtering, Multiplexing, Conversion techniques, Sensor interface design: Wheatstone bridge and operational amplifier circuits for various applications.				<b>9</b>	
<b>V</b>	<b>Data Acquisition System:</b> Data Acquisition: single channel and multi-channel data acquisition, Data logging, Interfacing of sensors using DAQ cards, Applications: automobile and biological systems. <b>Sensor Technology:</b> Process of developing sensors, Trends in sensor technology and IC sensors, Sensor array's and multi-sensor systems, Smart sensors, Industrial network and automation.				<b>9</b>	

## Andragogy

Class Room Lectures, Power point presentation, You Tube, Group Discussion, Seminar, Quiz, Formative Assessments, Brain storming, Activity

## COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1:</b>	Understand and evaluate different types of sensors for industrial applications.
<b>CO2:</b>	Learn the characteristics and selection criteria for electrical, pneumatic, and hydraulic actuators.
<b>CO3:</b>	Explain how devices measure parameters like temperature, pressure, flow, level, and displacement.
<b>CO4:</b>	Design sensor interfaces and set up data acquisition systems for real-time applications.
<b>CO5:</b>	Stay updated on sensor technology trends and perform laboratory experiments for hands-on learning.

## Text Books:

1. D.Patranabis, "Sensors and Actuators", 2nd Edition, PHI Learning, New Delhi, India,2013.
2. Ramon Pallas-Areny, John G. Webster, "Sensors and Signal Conditioning", 2nd Edition, Wiley India Pvt. Ltd., India, 2012.

## Reference Books:

1. D.Patranabis, "Sensors and Transducers", 2nd Edition, PHI Learning Pvt. Ltd., NewDelhi, India, 2011.
2. A.K. Sawhney, Puneet Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai and Co. Pvt. Ltd., New Delhi, India, 2014.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	3	2	1	2	2	2	3	3	3	3
CO2	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO3	3	3	3	3	2	3	3	3	2	3	3	3	3	2	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	2	3	3	2	2	3	3	3	3	3	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR152</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>V</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>ROBOT DESIGN</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To provide an understanding of the historical development and key innovations in robot mechanism design.</li> <li>• To introduce mathematical formulations for modeling both serial and parallel robot structures.</li> <li>• To teach simulation techniques for analyzing vibrations in two-wheeled self-balanced robots using MATLAB.</li> <li>• To explore path planning algorithms and their applications in special robotic operations.</li> <li>• To explain the principles of task-based robot design and optimization techniques for improving robot performance</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Historical Backgrounds on Robot Mechanism Design</b> Early Developments in Robotics, Evolution of Robotic Mechanisms, Key Innovations in Robot Design, Impact of Robotics on Industry, Future Trends in Robot Mechanism Design				<b>9</b>	
<b>II</b>	<b>Mathematical Formulations for Robot Modelling: Serial Versus Parallel Structures.</b> Overview of Serial and Parallel Structures, Mathematical Models for Serial Robots, Mathematical Models for Parallel Robots, Comparative Analysis of Serial and Parallel Structures, Applications and Limitations				<b>9</b>	
<b>III</b>	<b>Simulating Vibrations of Two-Wheeled Self-balanced Robots with Road Excitations by MATLAB</b> introduction to Two-Wheeled Self-Balanced Robots, Vibration Theory and Road Excitations, MATLAB Simulation Setup, Analysis of Simulation Results, Implications for Design and Stability				<b>9</b>	
<b>IV</b>	<b>Path Planning for Special Robotic Operations</b> Fundamentals of Robotic Path Planning, Path Planning Algorithms, Special Considerations for Complex Environments, Simulation and Testing of Path Planning, Real-World Applications				<b>9</b>	

<b>V</b>	<b>Robot Design: Optimization Methods and Task-Based Design</b> Principles of Task-Based Robot Design, Optimization Techniques in Robot Design, Case Studies in Task-Based Design, Performance Metrics and Evaluation, Innovations in Design Optimization	<b>9</b>
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**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1:</b>	Students will be able to describe the historical evolution and significant advancements in robotic mechanisms.
<b>CO2:</b>	Students will develop the ability to formulate and compare mathematical models for serial and parallel robot structures.
<b>CO3:</b>	Students will gain practical skills in simulating and analyzing vibrations in self-balanced robots using MATLAB.
<b>CO4:</b>	Students will understand and apply various path planning algorithms for complex robotic environments.
<b>CO5:</b>	Students will design optimized robotic systems tailored to specific tasks, using advanced design and performance evaluation techniques.

**Text Books:**

1. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, Robot Modeling and Control, Wiley, 1st Edition, 2005.
2. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, *Robotics: Modelling, Planning and Control*, Springer, 2nd Edition, 2010.

**Reference Books:**

1. Atnaik, Srikanta, "Robot Cognition and Navigation: An Experiment with Mobile Robots", Springer-Verlag Berlin and Heidelberg, 2007.
2. Spyros G. Tzafestas, "Introduction to Mobile Robot Control", Elsevier, 2021.
3. (Margaret E. Jefferies and Wai-Kiang Yeap, "Robotics and Cognitive Approaches to Spatial Mapping", Springer-Verlag Berlin Heidelberg, 2008.

**Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	0	1	1	0	0	0	2	0	0	0	1	3	2	0	0
CO2	3	3	0	2	3	0	0	0	0	0	1	3	2	0	0
CO3	3	3	3	2	2	0	0	0	0	0	3	3	2	1	1
CO4	2	3	1	3	2	0	0	0	0	0	1	3	2	1	1
CO5	3	3	2	3	3	0	0	0	0	0	1	3	2	1	1

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR153</b>	<b>Number of Hours/Week</b>	<b>4</b>			
<b>Semester</b>	<b>V</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>4</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>THEORY OF COMPUTATION</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>1</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To give an overview of the theoretical foundations of computer science from the perspective of formal languages.</li> <li>• To illustrate finite state machines to solve problems in computing</li> <li>• To familiarize Regular grammars and Context Free Grammar.</li> <li>• To solve various problems by normal form techniques, Push Down Automata and Turing Machines.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction-Finite Automata</b> Introduction to Computation and Formal Languages- Syntax and Semantics- Finite Automata- Alphabets - Strings and Languages - Automata and Grammars - Deterministic Finite Automata (DFA) - Formal Definition - Simplified notation: State transition graph - Transition table - Language of DFA - Nondeterministic Finite Automata (NFA) - NFA with epsilon transition - Language of NFA - Equivalence of NFA and DFA - Minimization of Finite Automata - Distinguishing one string from other - Myhill-Nerode Theorem.				<b>10</b>	
<b>II</b>	<b>Regular Expression (RE)</b> Definition - Operators of regular expression and their precedence - Algebraic laws for Regular expressions - Kleen's Theorem - Regular expression to FA - DFA to Regular expression - Arden Theorem - Non Regular Languages - Pumping Lemma for regular Languages. Application of Pumping Lemma - Closure properties of Regular Languages - Decision properties of Regular Languages - FA with output: Moore and Mealy machine - Equivalence of Moore and Mealy Machine - Applications and Limitation of FA.				<b>10</b>	
<b>III</b>	<b>Context Free Grammar (CFG) and Context Free Languages</b> Definition - Examples - Derivation - Derivation trees - Ambiguity in Grammar - Inherent ambiguity - Ambiguous to Unambiguous CFG - Useless symbols - Simplification of CFGs - Normal forms for CFGs: CNF and GNF - Closure properties of CFLs - Decision Properties of CFLs: Emptiness - Finiteness and Membership - Pumping lemma for CFLs.				<b>12</b>	
<b>IV</b>	<b>Push Down Automata (PDA)</b> Description and definition - Instantaneous Description - Language of PDA - Acceptance by Final state - Acceptance by empty stack - Deterministic PDA - Equivalence of acceptance by empty stack and final state - Conversion of CFG to PDA and PDA to CFG.				<b>12</b>	

<b>V</b>	<b>Turing Machines (TM) and Undecidability</b> Basic model - definition and representation - Instantaneous Description - Language acceptance by TM - Variants of Turing Machine - TM as Computer of Integer functions - Universal TM - Church's Thesis - Recursive and recursively enumerable languages - Halting problem - Introduction to Undecidability - Undecidable problems about TMs - Post correspondence problem (PCP) - Modified PCP and undecidable nature of post correspondence problem - Introduction to recursive function theory.	<b>12</b>
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**COURSE OUTCOMES:**

**On successful completion of this course, the student will be able to**

<b>CO1 :</b>	Design finite automata or regular expression for any tokenization task
<b>CO2 :</b>	Construct a context free grammar for parsing any language
<b>CO3 :</b>	Design Turing machine for any language
<b>CO4 :</b>	Conclude the decidable / undecidable nature of any language
<b>CO5 :</b>	Apply mathematical and formal techniques for solving real-world problems

**Text Book:**

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Introduction to Automata Theory Languages and Computation, 3<sup>rd</sup> edition, Pearson Education, India, 2007

**Reference Books:**

1. K. L. P Mishra, N. Chandrashekar, Theory of Computer Science-Automata Languages and Computation, 2<sup>nd</sup> edition, Prentice Hall of India, India, 2003

**Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	2	1	1	3	2	2	1	3	2	1
CO2	2	3	2	1	3	2	3	1	2	3	1	2	2	3	2
CO3	3	2	3	2	2	3	1	1	2	2	3	2	3	2	2
CO4	2	3	2	3	2	1	2	2	3	3	2	3	2	1	3
CO5	1	1	2	3	1	2	3	3	1	1	3	2	1	2	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR351</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>V (DSE III)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>SOFTWARE ENGINEERING</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To understand the nature of the software</li> <li>• To understand the different types of process models, agile developments and aspects of software engineer</li> <li>• To gain knowledge about the requirements stage and development of the software</li> <li>• To analyze the different types of architectural designs of the software</li> <li>• To evaluate different testing strategies of the software and Develop the software.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Unit I:</b> The Nature of Software - Software Engineering - Software Process.				<b>9</b>	
<b>II</b>	<b>Unit II: Process Models:</b> Prescriptive Process Models - <b>Agile Development - Human Aspects of Software Engineering</b>				<b>9</b>	
<b>III</b>	<b>Unit III: Understanding Requirements:</b> Requirements Engineering - Establishing the Groundwork Building the Analysis Model - Negotiating Requirements <b>Requirements Modeling: Scenario-Based Methods:</b> Requirements Analysis - Scenario-Based Modeling				<b>9</b>	
<b>IV</b>	<b>Unit IV: Design Concepts:</b> Design within the Context of Software Engineering - The Design Process - Design Concepts <b>Architectural Design:</b> Software Architecture - Architectural Genres - Architectural Styles - Architectural Considerations - Architectural Decisions - Architectural Design				<b>9</b>	
<b>V</b>	<b>Unit V:User Interface Design:</b> The Golden Rules - User Interface Analysis and Design - Interface Analysis - Interface Design Steps - WebApp and Mobile Interface Design - Design Evaluation. <b>Software Testing Strategies</b> - Software Testing Fundamentals. <b>Maintenance and Reengineering.</b>				<b>9</b>	

## COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1</b>	Understand the nature of the software
<b>CO2</b>	Understand the different types of process models, agile developments and aspects of software engineer
<b>CO3</b>	Gain knowledge about the requirements stage and development of the software
<b>CO4</b>	Analyze the different types of architectural designs of the software
<b>CO5</b>	Evaluate different testing strategies of the software and Develop the software

### Text Book

1. Roger S Pressman, “**Software Engineering a Practioner’s Approach**”, 9th Edition, McGraw- Hill Higher Education, 2023.

### Reference Books

1. Richard E.Fairly (2005), “Software Engineering” Concepts, Tata Mc Graw Hill Book Company.
2. Jawadekar (2004), “Software Engineering” ,Tata Mc Graw-Hill Book Company.
3. Dr. Richard Hall Thayer and Dr. Merlin Dorfman(2012 ), “Software Engineering Essentials, Volume I: The Development Process”, Software Management Training; Fourth edition,.

### **Mapping of Course Outcomes (CO’s) with PO’s & PSO’s**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	2	3	2	2	3	2	2	2	2	3
CO2	3	3	3	2	3	2	3	3	3	2	3	2	2	2	2
CO3	3	3	2	3	2	2	3	3	2	3	2	2	3	3	2
CO4	3	2	2	3	1	2	3	2	2	3	1	2	3	3	2
CO5	3	2	2	2	1	2	3	2	2	2	1	2	3	3	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR352</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>V (DSE III)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>NATURE INSPIRED COMPUTING</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students to:</b>						
<ul style="list-style-type: none"> <li>• Understand the Fundamentals of Bio-Inspired Computing.</li> <li>• Learn Evolutionary Models, Optimization Techniques and Explore Genetic Algorithms.</li> <li>• Investigate the biological basis of ant colonies and how this inspires optimization algorithms.</li> <li>• Explore variable-length PSO and its applications in optimization problems.</li> <li>• Application-Oriented Learning and Explore Advanced Nature-Inspired Algorithms.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction:</b> From Nature-to-Nature Computing, – Fundamentals of bio-inspired models and bio-inspired computing. Evolutionary models and techniques- Optimisation Problems-Single and multi-objective optimisation, heuristic, meta-heuristic and hyper heuristic functions.				<b>9</b>	
<b>II</b>	<b>Genetic Algorithms:</b> Genetic algorithms: Mathematical foundation, Genetic problem solving, crossover and mutation. Genetic algorithms and Markov process, applications of genetic algorithms.				<b>9</b>	
<b>III</b>	<b>Optimization Algorithms:</b> Ant Colonies, hybrid ant system, Ant Foraging Behavior, Ant Colony Optimization, SACO and scope of ACO algorithms, Ant Colony Algorithm (ACA), Variations of ACO.				<b>9</b>	
<b>IV</b>	<b>Swarm Algorithms:</b> Particle Swarm algorithms - particles moves, particle swarm optimization, variable length PSO, applications of PSO. Artificial Bee Colony algorithms - ABC basics, ABC in optimization, multi-dimensional bee colony algorithms, applications of bee algorithms.				<b>9</b>	
<b>V</b>	<b>Applications:</b> Selected nature inspired techniques - Bat algorithm- Cuckoo search algorithm. Deep Learning-Pattern recognition -Cybersecurity and its applications -Complex Network.				<b>8</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Apply nature-inspired computational techniques to solve real-world optimization and problem-solving tasks.
<b>CO2</b>	Demonstrate the ability to Implement Genetic Algorithms for Optimization and apply them to practical scenarios.
<b>CO3</b>	Utilize Ant Colony Optimization Techniques and evaluate the effectiveness of ACO algorithms in comparison to other optimization techniques.
<b>CO4</b>	Apply Swarm Intelligence Algorithms and analyse their applicability in real-world optimization problems.
<b>CO5</b>	Encourage creative and innovative problem-solving approaches by applying nature-inspired algorithms in emerging fields such as artificial intelligence, machine learning, and data science.

## **Text Book:**

1. Fundamentals of Natural Computing: Basic Concepts, Algorithms, and applications, L. N. de Castro (2006).
2. Leandro Nunes de Castro, "Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007
3. Evolutionary Optimization Algorithms, D. Simon (2013), Wiley

## **Reference Books:**

1. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA, 2008.
2. Albert Y.Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006.
3. Marco Dorigo, Thomas Stutzle," Ant Colony Optimization", PHI, 2005.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	2	1	2	1	2	1	2	3	2	2
CO2	3	3	3	3	3	2	1	2	1	3	2	3	3	2	2
CO3	2	3	3	3	2	2	1	3	2	3	2	2	3	2	2
CO4	3	2	3	2	3	3	1	2	2	3	2	3	3	2	3
CO5	3	3	3	3	3	3	2	2	3	3	2	3	3	3	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR353</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>V (DSE III)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>FUZZY SETS, LOGICS AND SYSTEMS</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To understand the fundamental concepts of fuzzy sets and fuzzy logic.</li> <li>• To learn fuzzy inference systems and rule-based decision-making.</li> <li>• To explore fuzzification, defuzzification, and ANFIS architecture.</li> <li>• To apply fuzzy systems in machine learning and real-world applications.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction and Fuzzy Set Theory:</b> Introduction to Fuzzy Logic and Soft Computing - Classical vs. Fuzzy Sets - Membership Functions: Types and Properties - Set Theoretic Operations on Fuzzy Sets.				<b>9</b>	
<b>II</b>	<b>Fuzzy Arithmetic and Fuzzy Relations:</b> Fuzzy Numbers and Arithmetic - Fuzzy Relations and Their Properties - Fuzzy Composition and Compatibility - Fuzzy Graphs and Clustering.				<b>8</b>	
<b>III</b>	<b>Fuzzy Inference System:</b> Fuzzy If-Then Rules - Rule-Based Systems Linguistic Variables & Hedges - Fuzzy Rule-Based Models <b>Rule-Based Models:</b> Mamdani and Sugeno FIS - Wang and Mendel Model - Takagi-Sugeno-Kang (TSK) Model - Difference Between Mamdani and TSK Models.				<b>9</b>	
<b>IV</b>	<b>Fuzzifiers, and Defuzzifiers:</b> Membership Function Design for Fuzzy Systems - Fuzzification & Defuzzification Techniques - Real-Time Defuzzification Applications. <b>ANFIS:</b> Introduction to Adaptive Neuro-Fuzzy Inference System (ANFIS) - ANFIS Architecture - Implementation and Examples.				<b>10</b>	
<b>V</b>	<b>Fuzzy Systems in Machine Learning:</b> Fuzzy Systems in Pattern Recognition and Clustering - Neuro-Fuzzy Systems - Evolutionary Fuzzy Systems.				<b>9</b>	

## Andragogy

Class Room Lectures, Power point presentation, You Tube, Group Discussion, Seminar, Quiz, Formative Assessments, Brain storming, Activity

## COURSE OUTCOMES:

On successful completion of this course, the student will be able to:

<b>CO1</b>	Define fuzzy sets, illustrate membership functions, and perform set operations.
<b>CO2</b>	Explain fuzzy arithmetic, classify fuzzy relations, and apply clustering techniques.
<b>CO3</b>	Compare fuzzy inference systems, analyze Mamdani, Sugeno, Wang-Mendel, and TSK models, and assess their effectiveness.
<b>CO4</b>	Evaluate fuzzification and defuzzification techniques, implement ANFIS architecture, and interpret results.
<b>CO5</b>	Identify fuzzy system applications, assess their role in machine learning, and differentiate between traditional and fuzzy-based approaches.

## Text book:

1. “Fuzzy logic with engineering applications”, Ross, T. J., John Wiley and Sons, 2005.
2. “Neuro-Fuzzy and Soft Computing”, J.-S. R. Jang, C.-T. Sun, and E. Mizutani, Prentice Hall, 1997.

## References:

1. “Uncertain Rule-Based Fuzzy Systems: Introduction and New Directions”, Mendel, J. M., Springer, 2<sup>nd</sup> Edition, 2017.
2. “Fuzzy Sets and Fuzzy Logic: Theory and Applications”, Klir, G. J., & Yuan, B., Prentice Hall, 1995.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	2	2	3	1	1	1	1	2	2	3	3	2	3
<b>CO2</b>	3	3	2	2	3	1	1	1	1	2	2	3	3	3	3
<b>CO3</b>	3	3	3	3	3	2	1	1	1	2	3	3	3	3	3
<b>CO4</b>	3	3	3	3	3	2	1	1	1	2	3	3	3	3	3
<b>CO5</b>	3	3	2	3	3	2	1	1	1	3	3	3	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR354</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>V (DSE IV)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>QUANTUM MACHINE LEARNING</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To introduce fundamental concepts of quantum computing and qubit operations.</li> <li>• To differentiate classical machine learning from quantum machine learning approaches.</li> <li>• To explore quantum circuit models, feature encoding, and variational algorithms.</li> <li>• To implement supervised and unsupervised learning techniques in quantum environments using tools like Qiskit.</li> <li>• To apply Quantum Neural Networks (QNNs), QGANs, and hybrid models to real-world datasets using quantum platforms.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>FUNDAMENTALS OF QUANTUM COMPUTING:</b> Introduction to Quantum Computing- Introduction to Superposition - Classical vs Quantum Superposition – Qubit - Mathematical Representation of Qubits - Bloch Sphere - Quantum Gates – Entanglement - Multi-Qubit States - CNOT Gate.				<b>9</b>	
<b>II</b>	<b>CLASSICAL VS. QUANTUM MACHINE LEARNING:</b> Classical vs. Quantum ML - Examples of Typical ML Problems - The Three Ingredients of a Learning Problem - Risk Minimization in Supervised Learning - Training in Unsupervised Learning - Methods in Machine Learning - Linear Models - Neural Networks - Graphical and Kernel Methods				<b>9</b>	
<b>III</b>	<b>QUANTUM ML: CIRCUITS AND ALGORITHMS:</b> Introduction to Quantum Machine Learning - Four Approaches to QML - Parameterized Quantum Circuits (PQC) - Quantum Information Encoding - Training Parameterized Quantum Circuits - Supervised Learning in QML - Quantum Variational Classification - Quantum Kernel Estimation - Quantum Feature Maps and Kernels - Quantum Support Vector Classification (QSVM)				<b>9</b>	
<b>IV</b>	<b>UNSUPERVISED QML &amp; PRACTICAL QISKIT:</b> Unsupervised Learning in QML - Principal Component Analysis (PCA) - Clustering Methods - Classifiers in QML - QML Programming Concepts in Qiskit - Problem-Solving Session using Qiskit - Analysis of Exercises from IBM Qiskit Summer School Challenges (2022 & 2023)				<b>9</b>	
<b>V</b>	<b>QUANTUM NEURAL NETWORKS &amp; GANs:</b> Introduction to Quantum Neural Networks (QNN) - Quantum Convolutional Neural Networks (QCNN) - Hybrid QNN - Problem Solving on a Real Dataset - Classical GANs - Quantum GANs (QGAN) - QGAN in Qiskit - Problem Solving with PennyLane and AWS Braket - Use Cases in Quantum Machine Learning				<b>9</b>	

## COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1</b>	Explain quantum computing principles including qubits, gates, and superposition.
<b>CO2</b>	Compare classical and quantum machine learning models and workflows.
<b>CO3</b>	Design quantum circuits for ML using PQC, feature maps, and QSVMs.
<b>CO4</b>	Implement supervised and unsupervised quantum learning models using Qiskit.
<b>CO5</b>	Apply QNNs, QGANs, and hybrid models to real-world problems using tools like Qiskit and PennyLane.

## Text Books:

1. **Maria Schuld and Francesco Petruccione**, *Machine Learning with Quantum Computers*, Second Edition, Springer, 2021.
2. **M.A. Nielsen and I.L. Chuang**, *Quantum Computation and Quantum Information*, 10th Anniversary Edition, Cambridge University Press, 2010.

## Reference Books:

1. Ciaran Hughes, Joshua Isaacson, Anastasia Perry, Ranbel F. Sun, Jessica Turner, *Quantum Computing for the Quantum Curious*, Springer, 2021.
2. Peter Wittek, *Quantum Machine Learning – What Quantum Computing Means to Data Mining*, Elsevier.
3. P. Kaye, R. Laflamme, and M. Mosca, *An Introduction to Quantum Computing*, Oxford University Press.
4. N. David Mermin, *Quantum Computer Science*, Cambridge University Press, 2007.
5. Qiskit Textbook – *Learn Quantum Computation using Qiskit*, IBM.  
<https://qiskit.org/textbook>
6. Qiskit Machine Learning Library Documentation:  
<https://qiskit.org/documentation/machine-learning/>

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	2	1	2	2	2	1	1	1	1	2	1	1	2	1
<b>CO2</b>	3	2	2	2	3	1	1	1	2	2	3	2	1	2	1
<b>CO3</b>	3	3	3	3	2	2	2	2	3	2	3	2	2	3	2
<b>CO4</b>	3	3	3	3	3	2	2	2	3	3	3	3	3	3	2
<b>CO5</b>	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR355</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>V (DSE IV)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>COGNITIVE COMPUTING</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To understand cognitive computing fundamentals and modeling techniques.</li> <li>• To explore decision-making and learning models in cognitive systems.</li> <li>• To analyze machine learning and NLP in cognitive computing.</li> <li>• To study cognitive analytics and AI applications.</li> <li>• To examine cognitive computing platforms and ethical considerations.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Fundamentals of Cognitive Computing:</b> Basics of Cognitive Computing – Cognitive Psychology – Architecture of the Mind – Cognitive Architectures – Nature of Cognitive Psychology – Cognitive Processes – Cognitive Modeling Paradigms – Declarative / Logic-Based Computational Cognitive Modeling – Connectionist Models – Bayesian Models.				<b>9</b>	
<b>II</b>	<b>Decision Support &amp; Learning Models:</b> Intelligent Decision Making – Fuzzy Cognitive Maps – Learning Algorithms: Nonlinear Hebbian Learning (NHL), Data-Driven NHL – Hybrid Learning – Fuzzy Grey Cognitive Maps – Dynamic Random Fuzzy Cognitive Maps.				<b>9</b>	
<b>III</b>	<b>Machine Learning &amp; NLP in Cognitive Systems:</b> Machine Learning Techniques for Cognitive Decision-Making – Hypothesis Generation and Scoring – Natural Language Processing (NLP) – Representing Knowledge – Taxonomies and Ontologies – N-Gram Models – Applications.				<b>9</b>	
<b>IV</b>	<b>Cognitive Analytics &amp; AI Applications:</b> Predictive Analytics – Text Analytics – Image Analytics – Speech Analytics – AI in Cognitive Systems – Cognitive Assistant for Visually Impaired – AI for Cancer Detection.				<b>8</b>	
<b>V</b>	<b>Cognitive Computing Platforms &amp; Case Studies:</b> IBM Watson – Introduction to IBM’s Power AI Platform – Google’s TensorFlow Development Environment – Real-World Cognitive Computing Case Studies in Healthcare, Business, and Automation - Ethical Considerations in Cognitive AI.				<b>10</b>	

### Andragogy

Class Room Lectures, Power point presentation, You Tube, Group Discussion, Seminar, Quiz, Formative Assessments, Brain storming, Activity.

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to:

<b>CO1</b>	Describe cognitive computing fundamentals, identify key aspects of cognitive psychology, and explain basic modeling techniques.
<b>CO2</b>	Compare decision-making models, differentiate learning algorithms, and examine their role in cognitive systems.
<b>CO3</b>	Apply machine learning models, use NLP techniques, and illustrate their role in decision-making.
<b>CO4</b>	Evaluate cognitive analytics methods, analyze AI applications, and discuss their industry impact.
<b>CO5</b>	Compare cognitive computing platforms, explore real-world use cases, and discuss ethical considerations.

## **Text book:**

1. “Cognitive Computing and Big Data Analytics”, Judith S. Hurwitz, Marcia Kaufman, and Adrian Bowles, Wiley, 2015.

## **References:**

1. “Quantum Models of Cognition and Decision”, Jerome R. Busemeyer and Peter D. Bruza, Cambridge University Press, 2<sup>nd</sup> Edition, 2024.
2. “Cognitive Science: An Introduction”, Neil A. Stillings, Steven E. Weisler, Christopher H. Chase, Mark H. Feinstein, Jay L. Garfield, and Edwina L. Rissland, MIT Press, 2<sup>nd</sup> Edition, 1995.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	2	2	3	1	1	1	1	2	2	3	3	2	3
<b>CO2</b>	3	3	3	3	3	1	1	1	1	2	2	3	3	3	3
<b>CO3</b>	3	3	3	3	3	2	1	1	1	2	3	3	3	3	3
<b>CO4</b>	3	3	3	3	3	2	1	2	1	2	3	3	3	3	3
<b>CO5</b>	3	3	2	3	3	3	2	3	2	3	3	3	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR356</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>V (DSE IV)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>NATURAL LANGUAGE PROCESSING</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• Understand the Fundamentals of Lexical Analysis</li> <li>• Explore Speech Processing Techniques</li> <li>• Learn Parsing Techniques and Algorithms</li> <li>• Develop Knowledge of Lexical Networks and Word Sense Disambiguation</li> <li>• Apply Natural Language Processing in Real-world Applications</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Lexical Analysis</b> Lexical Analysis - Regular expression and Automata for string matching - Words and Word Forms - Morphology fundamentals - Morphological Diversity of Indian Languages - Morphology Paradigms - Finite State Machine / Transducers Based Morphology - Automatic Morphology Learning - Parts of Speech - N-gram Models - Hidden Markov Models.				<b>9</b>	
<b>II</b>	<b>Speech Processing</b> Biology of Speech Processing - Place and Manner of Articulation - Word Boundary Detection - Argmax based computations - HMM and Speech Recognition - Text to Speech Synthesis - Rule Based-Concatenative based approach.				<b>9</b>	
<b>III</b>	<b>Parsing</b> Theories of Parsing - Parsing Algorithms – Earley Parser - CYK Parser - Probabilistic Parsing - CYK - Resolving attachment and structural ambiguity - Shallow Parsing - Dependency Parsing - Named Entity Recognition - Maximum Entropy Models - Conditional Random Fields.				<b>9</b>	
<b>IV</b>	<b>Lexical Knowledge Networks</b> Meaning: Lexical Knowledge Networks - Wordnet Theory - Indian Language Wordnets and Multilingual Dictionaries - Semantic Roles - Word Sense Disambiguation - WSD and Multilingualism - Metaphors - Coreference and Anaphora Resolution.				<b>9</b>	
<b>V</b>	<b>Applications</b> Applications: Sentiment Analysis - Text Entailment - Machine Translation - Question Answering System - Information Retrieval - Information Extraction - Cross Lingual Information Retrieval (CLIR).				<b>9</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1 :</b>	Ability to Analyze Lexical Structures
<b>CO2 :</b>	Competence in Speech Processing Techniques
<b>CO3 :</b>	Proficiency in Parsing Algorithms
<b>CO4 :</b>	Understanding and Application of Lexical Knowledge Networks
<b>CO5 :</b>	Application of NLP Techniques in Various Domains

## **Text Book**

1. Jurafsky Daniel, Martin James, "Speech and Language Processing", Second Edition, Tenth Impression, Pearson Education, 2018.
2. Christopher Manning, Schutze Heinrich, "Foundations of Statistical Natural Language Processing", MIT Press, 1999. Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Wiley publishers, Ninth edition, 2013.

## **Reference Books**

1. Allen James, "Natural Language Understanding", Second Edition, Benjamin Cumming, 1995.
2. Charniack Eugene, "Statistical Language Learning", MIT Press, 1993.
3. Foundations of Statistical Natural Language Processing, The MIT Press Cambridge, Massachusetts London, England, 1999.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>
<b>CO2</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>	<b>3</b>
<b>CO3</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>1</b>
<b>CO4</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>
<b>CO5</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>0</b>

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR251</b>	<b>Number of Hours/Week</b>	<b>2</b>			
<b>Semester</b>	<b>V</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>1</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>SENSOR AND ACTUATOR FOR ROBOTICS LAB</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>0</b>	<b>0</b>	<b>2</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students to:</b>						
<ul style="list-style-type: none"> <li>• Design and implement basic robotic systems integrating microcontrollers, sensors, and actuators to perform specified automation tasks.</li> <li>• Interface and program diverse sensors to acquire environmental data and convert physical parameters into actionable digital signals.</li> <li>• Control various actuators including motors, servos, and output devices using appropriate driver circuits and control algorithms.</li> <li>• Develop interactive embedded systems with closed-loop control, sensor fusion, and wireless communication capabilities.</li> <li>• Prototype and troubleshoot foundational robotic mechanisms by building and analyzing complete sensing-to-actuation signal pathways</li> </ul>						
<b>PROGRAMS</b>						
<ul style="list-style-type: none"> <li>• The "Hello World" of Robotics: LED Blink with a Twist (Controller + Actuator)</li> <li>• Sensing the Environment: Digital vs. Analog Input (Controller + Sensor)</li> <li>• Create a Smart Desk Lamp (Controller + Sensor + Actuator)</li> <li>• Measure Distance Like a Robot (Ultrasonic Sensor)</li> <li>• The Servo Sweep - Precise Angular Control (Actuator)</li> <li>• DIY Fan Speed Controller (Temperature Sensor + Motor)</li> <li>• Wireless Control via Smartphone (Bluetooth Communication)</li> <li>• Build a Mini Weather Station (Multiple Sensors + Display)</li> <li>• Line Follower Robot (Core Logic Prototype)</li> <li>• Motor Control &amp; Direction - The H-Bridge (Actuator Driver)</li> </ul>						

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR252</b>	<b>Number of Hours/Week</b>	<b>2</b>			
<b>Semester</b>	<b>V</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>1</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>ROBOT DESIGN LAB</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>0</b>	<b>0</b>	<b>2</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students for:</b>						
<ul style="list-style-type: none"> <li>• <b>To understand</b> the historical evolution and fundamental principles of robot mechanism design, distinguishing between serial and parallel robotic structures.</li> <li>• <b>To formulate</b> mathematical models for robotic systems using kinematic and dynamic analysis techniques for both serial and parallel configurations.</li> <li>• <b>To analyze</b> the dynamic behavior and stability of self-balancing robotic systems under various operating conditions and external excitations.</li> <li>• <b>To design</b> and implement efficient path planning algorithms for robotic operations in complex and dynamic environments.</li> <li>• <b>To apply</b> optimization techniques for task-based robot design, evaluating performance using appropriate engineering metrics.</li> </ul>						
<b>LIST OF EXPERIMENTS</b>						
<ol style="list-style-type: none"> <li>1. Evolution of Workspace: Serial vs. Parallel Robot Comparison</li> <li>2. Forward &amp; Inverse Kinematics of a SCARA Robot</li> <li>3. Singularity Analysis of a 5-Bar Parallel Manipulator</li> <li>4. Two-Wheeled Self-Balancing Robot: LQR Controller Design</li> <li>5. Vibration Analysis with Road Excitation Inputs</li> <li>6. A* vs. RRT Path Planning in Obstacle Field</li> <li>7. Dynamic Path Planning with D* Algorithm</li> <li>8. Genetic Algorithm Optimization of Robot Link Lengths</li> <li>9. Task-Based Gripper Design via Parameter Optimization</li> <li>10. Complete Pick-and-Place Workcell Simulation</li> </ol>						

### Course Outcomes:

By learning Computer Networks, students will be able to

<b>CO1:</b>	Explain the historical evolution and fundamental differences between serial and parallel robotic mechanisms.
<b>CO2:</b>	<b>Formulate</b> mathematical models for robotic systems using kinematic and dynamic analysis techniques.
<b>CO3:</b>	<b>Analyze</b> the stability and vibrational characteristics of self-balancing robots under various conditions.
<b>CO4:</b>	<b>Design</b> and evaluate path planning algorithms for robotic operations in complex environments.
<b>CO5:</b>	<b>Apply</b> optimization techniques for task-based robot design and performance evaluation.

### Mapping of Course Outcomes (CO's) with PO's & PSO's

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	3	2	2	2	2	2	3	3	2	2
CO2	3	3	3	2	3	2	2	3	2	2	3	3	3	3	3
CO3	3	2	3	3	3	3	3	2	2	3	2	2	2	3	3
CO4	3	2	3	2	2	3	2	3	2	2	3	3	2	2	2
CO5	2	3	3	3	3	3	2	3	2	2	3	3	3	3	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR851</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>V</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Skill Enhancement Course</b>						
<b>Course Title</b>	<b>PRINCIPLES OF MANAGEMENT</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• Understand the basic concepts and importance of management and its early thinkers.</li> <li>• Learn the purpose, steps, and methods of planning and decision making.</li> <li>• Know how organizations are structured and how authority is managed.</li> <li>• Understand how managers direct, lead, motivate, and communicate with teams.</li> <li>• Learn how controlling helps managers check progress and improve performance.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Fundamentals of Management:</b> Introduction Concepts, Objectives, Nature Scope and Significance of management Evolution of management thought-Contribution of Taylor, Weber and Fayol management.				<b>9</b>	
<b>II</b>	<b>Planning:</b> Concept, Objectives, Nature, Limitation, Process of planning, Importance, Forms, Techniques and Process of decision making.				<b>9</b>	
<b>III</b>	<b>Organizing:</b> Concept, Objectives, Nature of organizing, Types of Organization, delegation of authority, Authority and responsibilities, Centralization and Decentralization, Span of control.				<b>9</b>	
<b>IV</b>	<b>Directing:</b> Concept, Principles & Techniques of directing and Coordination Concept of leadership-Style. Importance, Styles, Supervision, Motivation, Importance Theory of Motivation, Communication.				<b>9</b>	
<b>V</b>	<b>Controlling:</b> Concept, Principles, Process and Techniques of Controlling, Relationship between planning and controlling.				<b>9</b>	

### COURSE OUTCOMES:

**On successful completion of this course, the student will be able to**

<b>CO1</b>	Discuss the management concepts, objectives, nature, scope, significance and evolution, with contributions from Taylor, Weber, and Fayol.
<b>CO2</b>	Illustrate the process of planning, including its objectives, forms, techniques and decision-making processes, explaining its importance and limitations in a management context.

<b>CO3</b>	Apply the principles of organizing by evaluating different organizational structures, analyzing delegation of authority, and assessing the impact of centralization and decentralization on business operations.
<b>CO4</b>	Examine the principles and techniques of directing, leadership styles and motivational theories, and analyze their significance in managing teams, ensuring effective communication, supervision and coordination within organizations.
<b>CO5</b>	Estimate the effectiveness of controlling processes and techniques and assess the relationship between planning and controlling to improve organizational performance.

**Text Book:**

1. D. Pagare, Principles of Management, 6th ed. New Delhi, India: Sultan Chand & Sons, 2018.

**Reference Books:**

1. L. M. Prasad, Principles and Practice of Management, 9th ed. New Delhi, India: Sultan Chand & Sons, 2016.
2. V. S. P. Rao and P. S. Narayana, Principles and Practice of Management. New Delhi, India: Konark Publishers Pvt. Ltd., 1987.
3. R. Srinivasan and S. A. Chunawalla, Management Principles and Practice, 1st ed. Mumbai, India: Himalaya Publishing House, 2014.

**Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	0	2	2	0	2	2	0	1	2	1	2	2	2	2
CO2	1	1	1	2	2	2	2	1	1	2	1	1	2	3	2
CO3	3	1	1	2	2	2	2	1	1	2	1	1	2	3	2
CO4	3	3	2	3	2	2	2	1	2	3	2	2	3	3	2
CO5	3	3	2	3	2	2	2	1	2	3	2	2	3	3	2

3 – high, 2 – Average, 1 - Low , 0-Null

# **Semester VI**

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR161</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VI</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>ROBOT PROGRAMMING</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• <b>To understand</b> the ROS2 architectural framework and its core components for robotic system development.</li> <li>• <b>To develop</b> ROS2 applications using nodes, topics, services, and actions with C++/Python programming.</li> <li>• <b>To implement</b> path planning algorithms including classic and probabilistic approaches for robotic navigation.</li> <li>• <b>To apply</b> localization and mapping techniques (EKF, MCL, SLAM) using ROS2 packages for autonomous systems.</li> <li>• <b>To deploy</b> micro-ROS on embedded platforms with RTOS for resource-constrained robotic applications</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	Introduction to ROS2: Architectural overview of the Robot Operating System, Framework and setup with ROS2 environment, ROS2 workspace structure, essential command line utilities. ROS2 nodes, topics, services, parameters, actions and launch files. Programming nodes, topics, services, actions with C/C++/Python. Real time programming with ROS2.				<b>9</b>	
<b>II</b>	Robot Simulation Engines: Physics simulations of Robots with Gazebo, Mujoco and Pybullet C++/Python APIs. Intro to Path Planning and Navigation, Classic Path Planning, Number of classic path planning approaches that can be applied to low-dimensional robotic systems. Coding the BFS and algorithms in C++. Sample-Based and Probabilistic Path Planning and improvement using the classic approach. Programming in Moveit framework.				<b>9</b>	
<b>III</b>	Use of the EKF ROS package to a robot to estimate its pose. Monte Carlo Localization: The Monte Carlo Localization algorithm which uses particle filters to estimate a robot's pose. Build MCL in C++: Coding the Monte Carlo Localization algorithm in C++. Simultaneous Localization and Mapping (SLAM) implementation with ROS2 packages and C++. Combining mapping algorithms with the localization concepts.				<b>9</b>	
<b>IV</b>	Introduction to the Mapping and SLAM concepts and algorithms. Occupancy Grid Mapping: Mapping an environment with the Occupancy Grid Mapping algorithm. Grid-based FastSLAM: Simultaneous mapping an environment and localize a robot relative to the map with the Grid-based FastSLAM algorithm.				<b>9</b>	

<b>V</b>	Concepts of microros, Client library, features of microros, real time operating systems (RTOS- Free RTOS, Zephyr), implementation of microros on ARM/ESP32 based microcontrollers.	<b>9</b>
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**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

CO1	Explain the historical evolution and fundamental differences between serial and parallel robotic mechanisms.
CO2	Formulate mathematical models for robotic systems using kinematic and dynamic analysis techniques.
CO3	Analyze the stability and vibrational characteristics of self-balancing robots under various conditions.
CO4	Design and evaluate path planning algorithms for robotic operations in complex environments..
CO5	Develop integrated robotic systems through comprehensive software simulation and validation.

**Text Books:**

1. Steven Macenski, "ROS 2 Robotics Projects: Build and control intelligent robots using Robot Operating System 2," Packt Publishing, 1st Edition, 2023, ISBN: 978-1804612168.
2. Anis Koubaa, "Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy," Apress, 2nd Edition, 2022, ISBN: 978-1484277492.

**Reference Books:**

1. Brian Gerkey, William D. Smart, "Programming Robots with ROS: A Practical Introduction to the Robot Operating System," O'Reilly Media, 1st Edition, 2015, ISBN: 978-1449323899.
2. Lentin Joseph, Jonathan Cacace, "Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 3rd Edition," Packt Publishing, 3rd Edition, 2021, ISBN: 978-1801071024.

**Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	2	1	2	1	2	1	3	2	3	2
CO2	3	3	2	3	2	1	1	1	1	2	1	2	3	3	2
CO3	3	3	3	2	3	1	1	1	1	2	2	2	3	3	2
CO4	3	2	2	2	3	1	1	1	1	2	1	2	3	3	2
CO5	2	3	3	2	3	2	2	2	2	3	2	3	3	3	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR162</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VI</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>COMPILER DESIGN</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To learn the various phases of compiler parsing techniques.</li> <li>• To understand intermediate code generation and run-time environment.</li> <li>• To learn to implement the front-end of the compiler.</li> <li>• To learn to implement code generator.</li> <li>• To learn to implement code optimization.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction To Compilers &amp; Lexical Analysis</b> Introduction- Translators- Compilation and Interpretation- Language processors -The Phases of Compiler – Lexical Analysis – Role of Lexical Analyzer – Input Buffering – Specification of Tokens – Recognition of Tokens – Finite Automata – Regular Expressions to Automata NFA, DFA – Minimizing DFA – Language for Specifying Lexical Analyzers – Lex tool.				<b>9</b>	
<b>II</b>	<b>Syntax Analysis:</b> Role of Parser – Grammars – Context-free grammars – Writing a grammar Top Down Parsing General Strategies – Recursive Descent Parser Predictive Parser-LL(1) – Parser-Shift Reduce Parser-LR Parser- LR (o)Item Construction of SLR Parsing Table – Introduction to LALR Parser Error Handling and Recovery in Syntax Analyzer-YACC tool – Design of a syntax Analyzer for a Sample Language				<b>9</b>	
<b>III</b>	<b>Syntax Directed Translation &amp; Intermediate Code Generation:</b> Syntax directed Definitions-Construction of Syntax Tree-Bottom-up Evaluation of S-Attribute Definitions- Design of predictive translator – Type Systems-Specification of a simple type Checker Equivalence of Type Expressions-Type Conversions. Intermediate Languages: Syntax Tree, Three Address Code, Types and Declarations, Translation of Expressions, Type Checking, Back patching.				<b>9</b>	
<b>IV</b>	<b>Run-Time Environment And Code Generation:</b> Runtime Environments – source language issues – Storage organization – Storage Allocation Strategies: Static, Stack, and Heap allocation – Parameter Passing-Symbol Tables – Dynamic Storage Allocation – Issues in the Design of a code generator – Basic Blocks and Flow graphs Design of a simple Code Generator – Optimal Code Generation for Expressions– Dynamic Programming Code Generation.				<b>9</b>	

<b>V</b>	<b>Code Optimization:</b> Classification of optimization, Principle sources of optimization, Optimization of basic blocks, Peephole Optimization, Loops in flow graphs, Local optimization, Global optimization, Data flow analysis of flow graph.	<b>9</b>
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**COURSE OUTCOMES:**

**On successful completion of this course, the student will be able to**

CO1	Learn Compiler phases, passes, and language translation mechanisms.
CO2	Understand the concept of token generation, parsing techniques, symbol table and intermediate code generation.
CO3	Apply syntax-directed translation to generate intermediate code representations, such as syntax trees and three-address code, and perform type checking.
CO4	Understand various types of errors and error handling techniques
CO5	Apply the code optimization algorithms.

**Text Book:**

1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, “Compilers: Principles, Techniques and Tools”, Second Edition, Pearson Education, 2009.

**Reference Books:**

1. Randy Allen, Ken Kennedy, Optimizing Compilers for Modern Architectures: A Dependence based Approach, Morgan Kaufmann Publishers, 2002.
2. Steven S. Muchnick, Advanced Compiler Design and Implementation, Morgan Kaufmann Publishers – Elsevier Science, India, Indian Reprint 2003.
3. Keith D Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann Publishers Elsevier Science, 2004.
4. V. Raghavan, Principles of Compiler Design, Tata McGraw Hill Education Publishers, 2010.
5. Allen I. Holub, Compiler Design in C, Prentice-Hall Software Series, 1993.

**Mapping of Course Outcomes (CO’s) with PO’s & PSO’s**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	2	1	1	3	2	2	1	3	2	1
CO2	2	3	2	1	3	2	3	1	2	3	1	2	2	3	2
CO3	3	2	3	2	2	3	1	1	2	2	3	2	3	2	2
CO4	2	3	2	3	2	1	2	2	3	3	2	3	2	1	3
CO5	1	1	2	3	1	2	3	3	1	1	3	2	1	2	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR163</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VI</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>INDUSTRIAL ELECTRONICS AND POWER CONVERTORS</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• Understand the principles of industrial electronics and power electronic devices.</li> <li>• Study the operation and characteristics of power semiconductor devices.</li> <li>• Analyze various types of power converters and their applications.</li> <li>• To explore industrial applications of power converters in aeronautical systems..</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	Introduction to Industrial Electronics: Role of Electronics in Industrial Systems. Power Semiconductor Devices – SCR, TRIAC, DIAC, MOSFET, IGBT. Characteristics and Triggering Circuits. Protection and Commutation Techniques.				<b>9</b>	
<b>II</b>	AC-DC Converters: Controlled Rectifiers – Single Phase and Three Phase. Output Voltage Calculation and Waveform Analysis. Performance Parameters – Ripple Factor, Efficiency. Applications in Battery Charging and Motor Drives.				<b>9</b>	
<b>III</b>	DC-DC Converters: Buck, Boost, Buck-Boost, and Cuk Converters. Modes of Operation, Waveform Analysis, and Design Considerations. Applications in Aircraft Power Systems				<b>9</b>	
<b>IV</b>	DC-AC and AC-AC Converters: Single and Three-Phase Inverters – PWM Techniques, Harmonic Reduction. Cycloconverters and Matrix Converters. Applications in Variable Frequency Drives and Aerospace Actuation Systems.				<b>9</b>	
<b>V</b>	Industrial Applications: Power Converter Applications in Avionics, Flight Control, Environmental Control Systems. Energy Management and Regeneration. Power Quality and EMI/EMC Considerations in Aeronautical Systems.				<b>9</b>	

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Understand the fundamentals and applications of industrial electronics.
<b>CO2</b>	Analyze the operation and performance of various power semiconductor devices.
<b>CO3</b>	Design and evaluate different types of power converters.
<b>CO4</b>	Apply power conversion principles in aeronautical systems.
<b>CO5</b>	Assess EMI/EMC and energy management aspects in aerospace power electronics.

### **Text Book**

1. M.D. Singh and K.B. Khanchandani – Power Electronics, McGraw-Hill, 3rd Edition, 2018.
2. Bimal K. Bose – Power Electronics and Motor Drives, Academic Press, 2006.

### **Reference Books**

1. Muhammad H. Rashid – Power Electronics: Circuits, Devices and Applications, Pearson, 4th Edition, 2013.
2. V.R. Moorthi – Power Electronics: Devices, Circuits and Industrial Applications, Oxford University Press, 2005..

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	2	3	2	2	1	1	1	2	2	1	2	2	2	1	2
<b>CO2</b>	2	2	2	0	2	0	0	3	1	1	1	0	3	0	2
<b>CO3</b>	0	1	3	3	3	2	0	1	1	3	2	3	3	2	3
<b>CO4</b>	1	3	2	3	0	2	1	0	0	1	1	0	2	1	3
<b>CO5</b>	1	2	3	1	3	2	1	1	1	1	1	0	3	1	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR261</b>	<b>Number of Hours/Week</b>	<b>2</b>			
<b>Semester</b>	<b>VI</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>1</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>ROBOT PROGRAMMING LAB</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>0</b>	<b>0</b>	<b>2</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students for:</b>						
<ul style="list-style-type: none"> <li>• <b>To establish</b> proficiency in ROS2 workspace setup, architecture, and command-line operations for robotic system development.</li> <li>• <b>To develop</b> ROS2 applications using core communication paradigms (topics, services, actions) with C++/Python programming.</li> <li>• <b>To implement</b> and compare classic and probabilistic path planning algorithms for autonomous robot navigation.</li> <li>• <b>To apply</b> localization and mapping techniques including EKF, MCL, and SLAM using ROS2 packages.</li> <li>• <b>To deploy</b> micro-ROS on embedded hardware platforms with real-time operating systems.</li> </ul>						
<b>LIST OF EXPERIMENTS</b>						
<ol style="list-style-type: none"> <li>1. <b>ROS2 Workspace Creation and Basic Command Line Operations</b></li> <li>2. <b>Publisher-Subscriber Communication with Custom Message Types</b></li> <li>3. <b>Service-Client Architecture for Robot Command Handling</b></li> <li>4. <b>Action Server Implementation for Long-Running Navigation Tasks</b></li> <li>5. <b>Mobile Robot Simulation in Gazebo with ROS2 Control</b></li> <li>6. <b>Breadth-First Search (BFS) Path Planning for Grid Navigation</b></li> <li>7. <b>Probabilistic Roadmap (PRM) Path Planning with RViz Visualization</b></li> <li>8. <b>Extended Kalman Filter (EKF) Implementation for Robot Localization</b></li> <li>9. <b>Monte Carlo Localization (MCL) Using Particle Filters</b></li> <li>10. <b>micro-ROS Deployment on ESP32 with FreeRTOS Integration</b></li> </ol>						

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Set up and navigate the ROS2 development environment, utilizing command-line tools and workspace management
<b>CO2</b>	Program ROS2 nodes implementing publisher-subscriber, service-client, and action-based communication patterns.
<b>CO3</b>	Design and code path planning algorithms, from grid-based searches (BFS) to sampling-based methods (PRM).
<b>CO4</b>	Implement localization (EKF, MCL) and mapping (Occupancy Grid, FastSLAM) algorithms for autonomous navigation.
<b>CO5</b>	Configure and run micro-ROS on microcontroller platforms (ESP32) integrated with a real-time operating system (FreeRTOS).

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>1</b>
<b>CO2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>
<b>CO3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>
<b>CO4</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>
<b>CO5</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR262</b>	<b>Number of Hours/Week</b>	<b>2</b>			
<b>Semester</b>	<b>VI</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>1</b>			
<b>Core Course</b>						
<b>Course Title</b>	<b>COMPILER DESIGN LAB</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>0</b>	<b>0</b>	<b>2</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students for:</b>						
<ul style="list-style-type: none"> <li>• Master lexical analysis tools – build both manual and Lex-based scanners to identify tokens accurately.</li> <li>• Design and implement parsers – convert grammars to YACC specifications, construct ASTs, and resolve syntax errors.</li> <li>• Apply semantic analysis – implement symbol tables, type checking, and control/data-flow analyses for semantic correctness.</li> <li>• Simulate run-time behavior – experiment with storage-allocation strategies and DAG construction to support code generation.</li> <li>• Introduce code optimisation techniques – perform basic-block, peephole, and global optimisations to improve compiled output efficiency.</li> </ul>						
<b>LIST OF EXPERIMENTS</b>						
<ol style="list-style-type: none"> <li>1. Implementation of Symbol Table</li> <li>2. Develop a lexical analyzer to recognize a few patterns in C. (Ex. identifiers, constants, comments, operators etc.)</li> <li>3. Implementation of Lexical Analyzer using Lex Tool</li> <li>4. Generate YACC specification for a few syntactic categories. <ol style="list-style-type: none"> <li>a) Program to recognize a valid arithmetic expression that uses operator +, -, * and /.</li> <li>b) Program to recognize a valid variable which starts with a letter followed by any number of letters or digits.</li> <li>c) Implementation of Calculator using LEX and YACC</li> </ol> </li> <li>5. Convert the BNF rules into Yacc form and write code to generate Abstract Syntax Tree.</li> <li>6. Implement type checking</li> <li>7. Implement control flow analysis and Data flow Analysis</li> <li>8. Implement any one storage allocation strategies (Heap, Stack)</li> <li>9. Construction of DAG</li> <li>10. Implementation of Simple Code Optimization Techniques.</li> </ol>						

## COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1</b>	Implement Lexical Analysis: Construct accurate tokenizers for a subset of C both manually and with Lex.
<b>CO2</b>	Develop Syntax Analyzers: Write YACC grammars, resolve conflicts, and generate Abstract Syntax Trees for arithmetic expressions, variables, and calculators.
<b>CO3</b>	Perform Semantic Checks: Build symbol tables, enforce type-checking rules, and validate programs for semantic correctness.
<b>CO4</b>	Analyze Program Flow & Storage: Generate control- and data-flow graphs, construct DAGs, and experiment with stack vs. heap allocation to model run-time behavior.
<b>CO5</b>	Optimize Intermediate Code: Apply basic-block, peephole, and global data-flow optimizations to improve execution efficiency of compiled code.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>
<b>CO2</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CO4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CO5</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR361</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VI (DSE V)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>APPLIED ARTIFICIAL INTELLEGEENCE</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To understand advanced concepts in artificial intelligence</li> <li>• To formulate artificial intelligence model with knowledge representation</li> <li>• To learn problem solving approaches through decision processes</li> <li>• To develop an AI model with the help of concepts such as searches, knowledge representation etc.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to AI and searches</b> Introducing the structure and scope of the course; Brief introduction and history of AI; state space searches; informed and uninformed searches; local searches; adversarial searches;				<b>9</b>	
<b>II</b>	<b>Logic in AI</b> Different knowledge representation systems; syntax; semantics; forward chaining; Resolution; Reduction in satisfiability problems; SAT solvers; DPLL algorithms; Walk SAT algorithms				<b>9</b>	
<b>III</b>	<b>Uncertainty in AI</b> Basics of probability; conditional independence and bayes rule; Bayesian networks – syntax, factorization, conditional independence and d-separation; inference using variable elimination; reducing 3-SAT to Bayes net; rejection sampling; likelihood weighing; MCMC with Gibbs sampling; maximum likelihood learning;				<b>9</b>	
<b>IV</b>	<b>Decision Theory</b> Steps in decision theory; non-deterministic uncertainty; probabilistic uncertainty and value of perfect information; expected utility and expected value; Markov decision process – policy evaluation using system of linear equations, iterative policy evaluation, value iteration, policy iteration and applications, extensions of MDPs				<b>9</b>	
<b>V</b>	<b>Reinforcement Learning</b> Background; Model based learning for policy evaluation; model free learning for policy evaluation; TD learning and computational neuroscience; Q Learning; Exploration vs Exploitation tradeoff; generalization in RL				<b>9</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Describe the history behind artificial intelligence
<b>CO2</b>	Illustrate fundamental AI concepts
<b>CO3</b>	Demonstrate problem formulation in state space search
<b>CO4</b>	Infers adversarial search with alpha-beta pruning
<b>CO5</b>	Develop an AI model for existing problems

## **Text Books:**

1. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach. Prentice Hall Press, USA, 3rd edition, 2009

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>3</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>3</b>	<b>2</b>	<b>0</b>	<b>0</b>
<b>CO2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>3</b>	<b>3</b>
<b>CO3</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>3</b>
<b>CO4</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>2</b>
<b>CO5</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR362</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VI (DSE V)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>NEUROMORPHIC COMPUTING</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students to:</b>						
<ul style="list-style-type: none"> <li>• Understand the fundamental principles of neuromorphic computing and its biological inspirations. (Remembering, Understanding)</li> <li>• Analyze different neuromorphic architectures, including spiking neural networks (SNNs) and hardware implementations. (Analyzing)</li> <li>• Design and implement simple neuromorphic models using computational frameworks. (Applying, Creating)</li> <li>• Evaluate the performance of neuromorphic systems in comparison to traditional computing paradigms. (Evaluating)</li> <li>• Apply neuromorphic computing techniques to solve real-world problems in robotics, artificial intelligence, and edge computing. (Applying, Creating)</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to Neuromorphic Computing</b> Basics of Neuromorphic Computing, Differences between Neuromorphic, Conventional, and AI-based Computing, Biological Inspiration: The Human Brain and Neurons, Historical Development of Neuromorphic Engineering, Key Applications of Neuromorphic Computing.				<b>9</b>	
<b>II</b>	<b>Neuromorphic Hardware and Architectures</b> Neuromorphic Processors: IBM TrueNorth, Intel Loihi, SpiNNaker, Analog vs Digital vs Mixed-Signal Neuromorphic Systems, Memristors and their Role in Neuromorphic Computing, Event-Driven Computing and Spiking Neural Networks (SNNs), Power Efficiency and Parallel Processing in Neuromorphic Chips.				<b>9</b>	
<b>III</b>	<b>Spiking Neural Networks (SNNs) and Learning Models</b> Introduction to Spiking Neural Networks (SNNs), Biological vs Artificial Neurons, Leaky Integrate-and-Fire (LIF) Model and Hodgkin-Huxley Model, Spike Timing-Dependent Plasticity (STDP) and Hebbian Learning, Training and Simulation Tools for SNNs (NEST, BindsNET, Brian2).				<b>9</b>	
<b>IV</b>	<b>Algorithms and Applications</b> Neuromorphic Vision and Auditory Processing, Brain-Inspired AI: Edge Computing and IoT Integration, Pattern Recognition and Sensor Fusion, Autonomous Robotics and Neuromorphic Control, Neuromorphic Computing in Medical Applications.				<b>9</b>	

<b>V</b>	<b>Future Trends and Challenges in Neuromorphic Computing</b> Limitations and Current Challenges in Neuromorphic Hardware, Quantum Computing vs Neuromorphic Computing, Hybrid AI: Combining Neuromorphic Computing with Deep Learning, Ethical and Societal Implications, Future Research Directions in Neuromorphic Computing.	<b>9</b>
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**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Explain the biological foundations of neuromorphic computing and its role in AI development. (Remembering, Understanding)
<b>CO2</b>	Differentiate between conventional computing and neuromorphic paradigms in terms of architecture and efficiency. (Understanding, Analyzing)
<b>CO3</b>	Implement spiking neural networks (SNNs) using tools like NEST, Brian2, or SpiNNaker. (Applying)
<b>CO4</b>	Critically evaluate neuromorphic computing applications and assess their feasibility for various domains. (Evaluating)
<b>CO5</b>	Develop prototype neuromorphic solutions for tasks such as pattern recognition, real-time decision-making, and IoT applications. (Creating)

**Text Books:**

1. Mohamed, Khaled Salah. "Neuromorphic Computing and Beyond." 2020.

**Reference Books:**

1. Anderson, James A., et al., eds. Neurocomputing. Vol. 2. MIT press, 1993.

**Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0
CO2	1	2	0	2	0	0	0	0	0	0	2	0	0	0	3
CO3	0	0	0	0	0	1	1	1	0	0	0	3	2	0	1
CO4	0	0	0	0	0	1	0	2	0	0	0	3	1	0	0
CO5	1	1	1	0	0	0	0	0	0	2	2	0	0	3	1

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR363</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VI (DSE V)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>COMPUTER VISION</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To introduce the fundamental concepts of computer vision, including image formation, feature extraction, and camera models.</li> <li>• To develop an understanding of image processing techniques such as edge detection, image segmentation, and feature extraction.</li> <li>• To study various algorithms for object detection, recognition, and tracking.</li> <li>• To explore advanced topics in computer vision, including 3D vision, motion analysis, and image stitching.</li> <li>• To apply computer vision methods to real-world applications, including robotics, augmented reality, and autonomous vehicles.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to Computer Vision</b> Overview of Computer Vision-History, scope, and applications of computer vision-Computer vision vs. image processing-Basic concepts: image formation, camera models, and projection-Image Representation and Properties-Color models -Image transformations.				<b>9</b>	
<b>II</b>	<b>Image Processing for Computer Vision</b> Image Preprocessing-Image enhancement -Image smoothing and filtering-Edge-Detection and Feature Extraction-Sobel, Canny, and Laplacian edge detection-Corner detection (Harris, FAST, SIFT, SURF)-Image Segmentation-Thresholding-Region-based segmentation -region growing, watershed-Clustering-based segmentation.				<b>9</b>	
<b>III</b>	<b>Geometric Transformations and Camera Models</b> Geometric Transformations-Affine and projective transformations-Homography and its applications in image stitching.Camera Models and Calibration-Pinhole camera model-Camera calibration techniques-intrinsic and extrinsic parameters-Depth estimation using stereo vision				<b>9</b>	
<b>IV</b>	<b>Object Detection and Recognition</b> Object Detection-Sliding window, Haar cascades, Histogram of Oriented Gradients features-Modern approaches -YOLO, SSD, Faster R-CNN-Object Recognition-Template matching, feature matching-Machine learning for object recognition -Deep learning-based recognition (CNNs)-Face Recognition-Eigenfaces, Fisherfaces-Deep learning approaches				<b>9</b>	

<b>V</b>	<b>Motion Analysis and Tracking</b> Optical Flow-Horn-Schunck and Lucas-Kanade methods for optical flow estimation-Motion segmentation-Object Tracking-Tracking algorithms -Kalman filter, Mean-shift, and CAMShift-Multi-object tracking-Visual odometry and motion capture	<b>9</b>
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### Andragogy

Class Room Lectures, Power point presentation, You Tube, Group Discussion, Seminar, Quiz, Formative Assessments, Brain storming, Activity

### COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1:</b>	Understand the core principles and techniques used in computer vision.
<b>CO2:</b>	Apply image processing algorithms for feature extraction, edge detection, and image segmentation.
<b>CO3:</b>	Implement object detection and recognition algorithms.
<b>CO4:</b>	Analyze motion in images and videos using optical flow and tracking techniques.
<b>CO5:</b>	Develop computer vision solutions for practical applications in robotics, augmented reality, and autonomous systems.

### Text Books:

1. **"Computer Vision: Algorithms and Applications"** by Richard Szeliski Publisher: Springer. ISBN: 978-1848829343
2. **"Computer Vision: A Modern Approach"** by David A. Forsyth and Jean Ponce, Publisher: Pearson, ISBN: 978-0136085928
3. **"Multiple View Geometry in Computer Vision"** by Richard Hartley and Andrew Zisserman, Cambridge University Press, ISBN: 978-0521540513
4. **"Deep Learning for Computer Vision"** by Rajalingappaa Shanmugamani, Publisher: Apress, ISBN: 978-1484229577

### Reference Books:

1. **"Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library"** by Adrian Kaehler and Gary Bradski, Publisher: O'Reilly Media, ISBN: 978-1491937996
2. **"Programming Computer Vision with Python: Tools and algorithms for analyzing images"** by Jan Erik Solem, Publisher: O'Reilly Media, ISBN: 978-1449316434

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	-	-	-	-	-	-	2	3	2	-
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	3	2
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR364</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VI (DSE VI)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>ROBOT CONTROL SYSTEMS</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To introduce the overview of robotic systems and their dynamics</li> <li>• To impart knowledge on system stability</li> <li>• To acquire knowledge on joint space and task space control schemes</li> <li>• To understand the concept of nonlinear control and observer schemes</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	INTRODUCTION AND OVERVIEW OF ROBOTIC SYSTEMS AND THEIR DYNAMICS Forward and inverse dynamics. Properties of the dynamic model and case studies. Introduction to nonlinear systems and control schemes.				<b>9</b>	
<b>II</b>	SYSTEM STABILITY AND TYPES OF STABILITY Lyapunov stability analysis, both direct and indirect methods. Lemmas and theorems related to stability analysis.				<b>9</b>	
<b>III</b>	JOINT SPACE AND TASK SPACE CONTROL SCHEMES Position control, velocity control, trajectory control and force control				<b>9</b>	
<b>IV</b>	NONLINEAR CONTROL SCHEMES Proportional and derivative control with gravity compensation, computed torque control, sliding mode control, adaptive control, observer-based control, robust control and optimal control.				<b>9</b>	
<b>V</b>	NONLINEAR OBSERVER SCHEMES: Design based on acceleration, velocity and position feedback. Numerical simulations using software packages namely MATLAB/MATHEMATICA.				<b>9</b>	

## COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1</b>	Understand basic concept of robotic systems and their dynamics.
<b>CO2</b>	Analyze system stability and types of stability
<b>CO3</b>	Know about joint space and task space control schemes
<b>CO4</b>	Understand the concept of nonlinear control and observer schemes
<b>CO5</b>	Understand basic concept of robotic systems and their dynamics.

## Text Books:

1. R Kelly, D. Santibanez, LP Victor and Julio Antonio, –Control of Robot Manipulators in Joint Space, Springer, 2005.
2. A Sabanovic and K Ohnishi, –Motion Control Systems, John Wiley & Sons (Asia), 2011

## Reference Books:

1. R M Murray, Z. Li and SS Sastry, –A Mathematical Introduction to Robotic Manipulation, CRC Press, 1994.
2. J J Craig, –Introduction to Robotics: Mechanics and Control, Prentice Hall, 4th Ed, 2018.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	0	1	0	0	0	1	0	3	0	1	2
CO2	3	2	1	3	1	0	2	0	0	1	0	2	1	2	3
CO3	3	2	2	3	3	2	3	0	0	2	0	2	2	2	3
CO4	2	3	1	2	3	1	2	1	1	1	1	2	2	1	3
CO5	3	2	3	3	3	2	3	3	3	2	2	2	3	3	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR365</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VI (DSE VI)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>INTERNET OF THINGS</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To understand the fundamentals, applications, and challenges of IoT.</li> <li>• To explore IoT system design, architecture, and embedded systems.</li> <li>• To analyze IoT communication protocols and networking techniques.</li> <li>• To study IoT data analytics, cloud integration, and machine learning applications.</li> <li>• To examine real-world IoT applications, security challenges, and future trends.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to IoT:</b> Basics of IoT – IoT Characteristics – IoT Applications – Challenges in IoT – Smart Homes – Healthcare – Agriculture – Industrial IoT – Security and Privacy in IoT – Best Practices in IoT System Design.				<b>9</b>	
<b>II</b>	<b>IoT Architecture &amp; Design Methodology:</b> IoT System Design – IoT Architecture Layers – Embedded Systems for IoT – Sensors & Actuators – Interfacing Techniques – Power Management in IoT Devices.				<b>9</b>	
<b>III</b>	<b>IoT Communication &amp; Networking:</b> Wireless Communication Protocols – Bluetooth – Wi-Fi – Zigbee – LoRa – 5G – IoT Protocol Stack – MQTT – CoAP – Data Transmission in IoT – Designing Low-Power and Scalable IoT Networks – Edge and Fog Computing.				<b>9</b>	
<b>IV</b>	<b>IoT Data Analytics &amp; Cloud Integration:</b> Data Collection & Storage – Cloud Computing for IoT – AWS IoT – IBM Watson – Google Cloud IoT – IoT Data Processing – AI & Machine Learning in IoT – Data Encryption & Secure Storage Methods.				<b>9</b>	
<b>V</b>	<b>IoT Applications &amp; Case Studies:</b> IoT in Smart Cities – IoT in Healthcare – Predictive Maintenance – IoT-Based Automation – Security & Ethical Issues in IoT – Legal and Privacy Considerations – Future Trends in IoT.				<b>9</b>	

### Andragogy

Class Room Lectures, Power point presentation, You Tube, Group Discussion, Seminar, Quiz, Formative Assessments, Brain storming, Activity.

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to:

<b>CO1</b>	Define IoT fundamentals, classify IoT characteristics, and analyze security aspects.
<b>CO2</b>	Develop IoT systems, integrate embedded components, and configure sensors and actuators.
<b>CO3</b>	Implement IoT communication protocols, analyze networking techniques, and demonstrate their applications.
<b>CO4</b>	Deploy IoT solutions on cloud platforms, process IoT data, and assess system performance.
<b>CO5</b>	Compare IoT applications, assess security risks, and justify ethical considerations.

## **Text book:**

1. “Internet of Things for Architects”, Perry Lea, Packt Publishing, 2018.

## **References:**

1. “Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry”, Maciej Kranz, Wiley, 2016.
2. “Designing the Internet of Things”, Adrian McEwen and Hakim Cassimally, Wiley, 2013.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>
<b>CO2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CO3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CO4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>CO5</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR366</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VI (DSE VI)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>III</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>GAME THEORY FOR ROBOTICS</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• Master formal logic to precisely specify system requirements.</li> <li>• Analyze probabilistic systems using model checking techniques.</li> <li>• Model and analyze systems with probabilistic and temporal behavior using MDPs and temporal logic.</li> <li>• Synthesize controllers and strategies using game-theoretic methods.</li> <li>• Apply formal methods to solve problems in robotics, cyber-physical systems, and strategic decision-making</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to Game Theory and Robotics</b> - Fundamental principles of game theory, game theory in robotics, multi-agent systems (strategic decision-making, players, strategies, payoffs, and Nash equilibrium). Application of game-theoretic concepts cooperative and non-cooperative robotic environments, (task allocation, resource sharing, and coordination between autonomous agents.				<b>9</b>	
<b>II</b>	<b>Strategic Form Games and Applications to Robotics:</b> Robotic interactions as strategic form games, Nash equilibrium, Dominant strategies, Mixed strategies in multi-robot systems, Collaborative navigation, Swarm robotics, Competitive task assignments, Analyzing and solving real-world robotic problems through game-theoretic models				<b>9</b>	
<b>III</b>	<b>Sequential Games and Decision-Making in Robotics:</b> Extensive form games and sequential decision-making. Backward induction, Subgame perfect equilibrium for multi-step tasks, Negotiation in robotic systems, Conflict resolution in robotic systems, Multi-step planning in autonomous robotics, Sequential task assignment, Interaction in dynamic environments				<b>9</b>	
<b>IV</b>	<b>Stochastic and Repeated Games in Multi-Agent Systems:</b> Stochastic games, Repeated game theory, Markov decision processes (MDPs), Strategies for cooperation in repeated games, Strategies for punishment in repeated games, Learning in multi-agent systems, Cooperative control, Motion planning in uncertain environments, Adaptive behavior of autonomous agents				<b>9</b>	
<b>V</b>	<b>Cooperative Game Theory and Mechanism Design for Robotics:</b> Cooperative game theory, Coalition formation, Cooperative behaviour Transferable utility games, Mechanism design, Incentive alignment Distributed control, Auction-based task allocation, Collaborative mission planning				<b>9</b>	

## **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Formally specify system requirements using appropriate logical formalisms.
<b>CO2</b>	Apply probabilistic model checking techniques to verify properties of probabilistic systems
<b>CO3</b>	Model and analyze systems with probabilistic and temporal aspects using Markov Decision Processes and temporal logic.
<b>CO4</b>	Synthesize controllers and strategies for reactive systems using game-theoretic methods
<b>CO5</b>	Apply formal methods to analyze and design solutions for problems in robotics, cyber-physical systems, and strategic decision-making.

## **Text Books:**

- Handbook of Game Theory with Economic Applications, edited by H. Peyton Young and Shmuel Zamir
- Principles of Model Checking by Christel Baier and Joost-Pieter Katoen:

## **Reference Books:**

4. **Decision Making Under Uncertainty: Theory and Application** by Mykel J. Kochenderfer: Spyros G. Tzafestas, "Introduction to Mobile Robot Control", Elsevier, 2021.
5. (Margaret E. Jefferies and Wai-Kiang Yeap, "Robotics and Cognitive Approaches to Spatial Mapping", Springer-Verlag Berlin Heidelberg, 2008.

## **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	0	2	0	2	0	0	0	0	0	0	0	0	1	0
CO2	0	2	0	1	1	0	2	0	3	0	1	2	2	1	3
CO3	0	0	0	1	0	0	2	0	0	0	0	0	2	3	1
CO4	0	2	2	0	1	2	0	0	3	0	0	1	1	0	0
CO5	3	0	2	0	0	0	0	0	1	1	0	0	1	2	3

3 – high, 2 – Average, 1 - Low , 0-Null

# **Semester VII**

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>		
<b>Course Code</b>	<b>25BTAR171</b>	<b>Number of Hours/Week</b>	<b>3</b>		
<b>Semester</b>	<b>VII</b>	<b>Max. Marks</b>	<b>100</b>		
<b>Year</b>	<b>IV</b>	<b>Credits</b>	<b>3</b>		
<b>Core Course</b>					
<b>Course Title</b>	<b>ROBOT DYNAMICS AND TRAJECTORY PLANNING</b>	<b>L</b>	<b>T</b>	<b>P</b>	
		<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>					
<b>COURSE OBJECTIVES:</b>					
<b>The main learning objective of this course is to prepare the students:</b>					
<ul style="list-style-type: none"> <li>• Introduce the fundamentals of robotics, including components, degrees of freedom, and spatial transformations.</li> <li>• Develop an understanding of manipulator kinematics, inverse kinematics, and Jacobian analysis.</li> <li>• Provide knowledge of manipulator dynamics, velocities, and static forces using Newton-Euler and Lagrangian methods.</li> <li>• Enable the design and analysis of manipulator mechanisms, actuation systems, and motion control.</li> <li>• Teach trajectory and motion planning, focusing on kinematic models, constraints, and advanced planning techniques.</li> </ul>					
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>
<b>I</b>	<b>Introduction, Spatial Descriptions and Transformations</b> Introduction: Fundamentals and robot - components, joints, degrees of freedom, coordinates. The mechanics & control of mechanical manipulators. Spatial Descriptions and Transformations: Descriptions – Positions, Orientations, and Frames, Mappings, Operators – Translations, Rotations, and Transformations, Transformation arithmetic and transform equations, transformation of free vectors, Representation & Orientation.				<b>9</b>
<b>II</b>	<b>Manipulator Kinematics ; Manipulator Kinematics: Links &amp; Connections.</b> Actuator Space, Joint Space and Cartesian Space. Tools & Computational considerations <b>Inverse Manipulator Kinematics</b> Solvability, Algebraic and Geometric. Standard Frames, Repeatability and Accuracy. Jacobians: Velocities and Static Forces: Time varying position and orientation.				<b>9</b>
<b>III</b>	<b>Velocities and Static Forces</b> Linear and rotational velocity of rigid bodies. Jacobians & Singularities. Cartesian transformation of velocities and static forces. <b>Manipulator Dynamics</b> Mass Distribution. Newton’s and Euler’s Equations. Iterative and Closed Form. Lagrangian formulation of manipulator dynamics. Manipulator Dynamics in Cartesian Space. Non-rigid body effects.				<b>9</b>
<b>IV</b>	<b>Manipulator-Mechanism Design</b> Kinematic Configuration. Workspace measures and attributes. Redundant and closed chain structures. Actuation Schemes, Stiffness & Deflections. Position Sensing & Force Sensing. <b>Motion Control Systems</b> Basic components & terminology. System Dynamics. Laplace transform and inverse Laplace transform. First and second order transfer				<b>9</b>

	functions. Proportional and proportional plus controllers. State space control methodology. Digital control and non-linear control systems.	
<b>V</b>	<b>Trajectory Planning</b> Path and Trajectory, Operational Space Trajectories <b>Motion Planning</b> Nonholonomic Constraints, Kinematic Model, Chained form, Dynamic Model, Planning, Motion Control, Odometric Localization, Configuration Space, Planning via Retraction, Planning via Cell Decomposition, Probabilistic Planning, Planning via Artificial Potentials	<b>9</b>

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Understand robot components, spatial descriptions, and transformations in mechanics and control.
<b>CO2</b>	Analyze manipulator kinematics, including inverse kinematics and Jacobian matrices.
<b>CO3</b>	Apply manipulator dynamics and calculate velocities and static forces in robotic systems.
<b>CO4</b>	Design manipulator mechanisms and use motion control systems with transfer functions.
<b>CO5</b>	Plan and implement robot trajectories, considering motion constraints and planning techniques.

**Text Books:**

1. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Robotics: Modelling, Planning and Control, Springer Publishing Company, 2010.
2. M.W. Spong, S. Hutchinson and M. Vidyasagar, Robot Modeling and Control, 2nd Edition, JOHN WILEY & SONS, INC, 2020.

**Reference Books:**

1. Daniel L. Ryan, Robotic Simulation, First Edition, CRC Press, 1993.
2. John Brown, Robot Simulation and Programming: From Simulation to Real World Implementation, E-book 2018

**Mapping of Course Outcomes (CO's) with PO's & PSO's**

<b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	2	2	3	2	3	2	1	2	1	3	3	3	2
<b>CO2</b>	3	3	3	3	3	2	2	2	1	3	2	3	3	3	3
<b>CO3</b>	3	3	3	3	3	2	2	2	1	3	2	3	3	3	3
<b>CO4</b>	3	3	3	3	3	2	2	2	1	2	2	3	2	3	3
<b>CO5</b>	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>		
<b>Course Code</b>	<b>25BTAR172</b>	<b>Number of Hours/Week</b>	<b>3</b>		
<b>Semester</b>	<b>VII</b>	<b>Max. Marks</b>	<b>100</b>		
<b>Year</b>	<b>IV</b>	<b>Credits</b>	<b>3</b>		
<b>Core Course</b>					
<b>Course Title</b>	<b>ETHICS, POLICY, LAWS AND STANDARDS IN AI</b>	<b>L</b>	<b>T</b>	<b>P</b>	
		<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>					
<b>COURSE OBJECTIVES:</b>					
<b>The main learning objective of this course is to prepare the students for:</b>					
<ul style="list-style-type: none"> <li>● <b>Understand</b> the fundamental ethical theories and principles relevant to Artificial Intelligence. (<i>Bloom's Level: Understand - Comprehension</i>)</li> <li>● <b>Analyze</b> the societal and ethical implications of AI in various domains such as healthcare, finance, and criminal justice. (<i>Bloom's Level: Analyze - Analysis</i>)</li> <li>● <b>Evaluate</b> the role of policies, laws, and regulatory frameworks governing AI technologies worldwide. (<i>Bloom's Level: Evaluate - Evaluation</i>)</li> <li>● <b>Apply</b> ethical reasoning and legal compliance in AI design, development, and deployment. (<i>Bloom's Level: Apply - Application</i>)</li> <li>● <b>Create</b> AI governance strategies and responsible AI frameworks that align with ethical and legal standards. (<i>Bloom's Level: Create - Synthesis</i>).</li> </ul>					
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>
<b>I</b>	<b>Introduction to AI Ethics</b> Definition & Scope of AI Ethics, Key Ethical Theories & Their Relevance to AI (Utilitarianism, Deontology, Virtue Ethics, etc.), Ethical Dilemmas in AI (Bias, Privacy, Accountability, etc.), Historical Cases of AI Ethical Issues (Cambridge Analytica, Facial Recognition Bias, etc).				<b>9</b>
<b>II</b>	<b>Ethical Issues in AI Development and Deployment</b> Bias and Fairness in AI (Algorithmic Bias, Discrimination, Explainability), AI and Privacy Concerns (Surveillance, Data Protection, Consent), Transparency and Explainability in AI Systems, AI and Human Autonomy (Manipulation, Misinformation, Deepfakes), AI and Environmental Impact				<b>9</b>
<b>III</b>	<b>AI Laws, Policies, and Regulations</b> Global AI Regulations (GDPR, AI Act (EU), USA AI Executive Orders, etc.), Intellectual Property Rights & AI (Ownership of AI-generated Content), Liability and Accountability in AI Systems (Who is responsible for AI decisions?), AI in Criminal Justice & Law Enforcement (Predictive Policing, Sentencing Algorithms), Corporate AI Governance Policies.				<b>9</b>
<b>IV</b>	<b>AI Standards and Frameworks</b> IEEE and ISO Standards for AI, NIST AI Risk Management Framework, Fairness, Accountability, and Transparency (FAT) Guidelines, Ethical				<b>9</b>

	AI Principles by Organizations (UNESCO, OECD, Google, etc.), AI Auditing and Compliance.	
V	<b>Future Challenges and Ethical AI Governance</b> AI and Job Displacement: Ethical & Policy Implications, Artificial General Intelligence (AGI) and Superintelligence Ethics, AI in Military & Autonomous Weapons, Regulatory Challenges in a Rapidly Evolving AI Landscape, Building Ethical AI: Best Practices for Researchers & Developers.	9

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Explain key ethical theories and principles applied to AI governance. (Bloom’s Level: Understand - Comprehension)
<b>CO2</b>	Examine real-world case studies to identify ethical dilemmas and biases in AI systems. (Bloom’s Level: Analyze - Analysis)
<b>CO3</b>	Assess the effectiveness of existing AI regulations, laws, and policies in different countries. (Bloom’s Level: Evaluate - Evaluation)
<b>CO4</b>	Demonstrate ethical decision-making in AI system design considering legal and societal impacts. (Bloom’s Level: Apply - Application)
<b>CO5</b>	Develop policy recommendations and AI ethics frameworks to ensure fair and accountable AI deployment. (Bloom’s Level: Create - Synthesis)

**Text Books:**

1. Floridi, Luciano, ed. Ethics, governance, and policies in artificial intelligence. Cham: Springer, 2021.

**Reference Books:**

1. Tzimas, Themistoklis. Legal and ethical challenges of artificial intelligence from an international law perspective. Vol. 46. Springer Nature, 2021.

**Mapping of Course Outcomes (CO’s) with PO’s & PSO’s**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	0	0	0	0	0	0	0	1	0	0	0	2	0	0
CO2	2	0	0	1	0	1	1	0	0	0	2	0	0	1	0
CO3	0	0	0	0	0	1	2	1	0	0	2	3	1	0	0
CO4	1	0	0	0	0	1	1	0	0	2	0	0	0	3	0
CO5	2	0	0	0	1	1	0	0	0	2	1	0	0	1	1

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR371</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VII (DSE VII)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>IV</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>INTERNET OF ROBOTIC THINGS (RIOT)</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• Understand the drivers and enablers of Industry 4.0.</li> <li>• Appreciate the smartness in Smart Factories, Smart cities, smart products and smart services.</li> <li>• Able to outline the various systems used in a manufacturing plant and their role in an Industry 4.0 world.</li> <li>• Appreciate the power of Cloud Computing in a networked economy.</li> <li>• Understand the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	IoT Foundations: Introduction to Internet of Things, An Overview Introduction – Definition and characteristics of IoT, Physical design of IoT- Things in IoT, IoT protocol, Logical design of IoT – IoT functional blocks, IoT Communication Models, Introduction to SDN, SDN for IoT, Data Handling and Analytics, Cloud Computing, Sensor-Cloud, Fog Computing, Examples of IoT based Systems: Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT..				<b>9</b>	
<b>II</b>	IoT Architecture and its Protocols: Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi.				<b>9</b>	
<b>III</b>	Sensors for IoT: Sensing and actuation, types of sensors, Occupancy Sensors, Motion sensor, velocity, temperature, pressure, chemical, Gyroscopic sensor, Optical sensors, Humidity, Water Quality sensors, Sensor applications.				<b>9</b>	
<b>IV</b>	Actuator for IoT: Actuator types, working principle of actuators, integration of sensors and actuators with arduino, formation of actuators, selection criteria for right actuator, maintenance of actuators, smart material actuators.				<b>9</b>	
<b>V</b>	Applications of IoT in Robotics: Future farming with the Internet of things, drones for surveillance, Soft low-power robotics, Tracking sensors for underwater robotics, Disaster response, Medical services, Smart restaurant, Analysis of IoT applications and Sensors, Space robotics for science and space exploration, Satellite based Internetworking, Tele operators, Space component systems like				<b>9</b>	

	rover mobility, locomotion and guidance. Future of RIOT: Powering insect-scale wireless robotics, Big data analysis, Augmented Reality, Additive manufacturing, Cyber security, the industrial internet of things, the cloud, Horizontal and vertical system integration, simulation, Autonomous robot.	
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### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Identify and explain the key technological drivers and enabling technologies of Industry 4.0.
<b>CO2</b>	Analyze the features and integration of smart systems in factories, cities, products, and services.
<b>CO3</b>	Describe the architecture and interoperation of manufacturing systems (e.g., MES, SCADA, ERP) within an Industry 4.0 framework.
<b>CO4</b>	Evaluate the role and impact of Cloud Computing and data analytics in a connected industrial ecosystem.
<b>CO5</b>	Assess the socio-economic opportunities, challenges, and strategic readiness required for organizations and individuals to benefit from Industry 4.0.

### **Text Book**

1. Vijay Madiseti and Arshdeep Bahga, Internet of Things (A Hands-on Approach), 1st Edition, VPT, 2014.
2. Korf Richard, "Space Robotics", Carnegie-Mellon University, The Robotics Institute 1982.

### **Reference Books**

1. Lewin A.R.W. Edwards, "Open source robotics and process control cookbook", Elsevier Publications, 2005.
2. (ii) Francis DaCosta, Rethinking the Internet of Things: A Scalable Approach to Connectin Everything, 1st Edition, Apress Publications, 2013.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	2	1	1	2	1	2	1	2	3	1	3
CO2	3	2	1	0	2	2	0	2	1	1	1	0	3	0	2
CO3	2	0	3	3	3	3	0	1	1	3	2	3	2	3	2
CO4	2	3	1	3	0	3	1	0	0	1	0	0	2	2	2
CO5	3	2	3	1	3	2	1	3	2	2	2	0	3	1	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR372</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VII (DSE VII)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>IV</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>BIONICS</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students to:</b>						
<ul style="list-style-type: none"> <li>• To understand the fundamentals of bionics and how biological systems inspire intelligent technologies.</li> <li>• To explore biologically inspired sensing and actuation mechanisms used in robotic systems.</li> <li>• To study computational models and algorithms inspired by neural and evolutionary systems.</li> <li>• To analyze and design robotic systems based on biological locomotion and swarm behavior.</li> <li>• To investigate real-world applications, innovations, and emerging trends in bionic technologies.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>					<b>HOURS</b>
<b>I</b>	Introduction to Bionics and Biological Inspiration: Definition and Scope of Bionics-Historical evolution and significance in AI and Robotics-Biological systems as models: sensory, neural, muscular systems-Overview of bio-mimicry in engineering: principles and case studies-Ethical considerations and future trends in Bionics.					<b>9</b>
<b>II</b>	Bio-Inspired Sensors and Actuators: Human sensory systems and their engineering counterparts-Artificial vision: image sensing inspired by eyes-Artificial olfaction, gustation, and tactile sensing Bio-inspired actuators: muscles, tendons, pneumatic and hydraulic systems-Smart materials: shape-memory alloys, electroactive polymers.					<b>9</b>
<b>III</b>	Neuromorphic and Bio-Inspired Computation:Neural encoding and spiking neuron models-Neuromorphic computing architectures Introduction to Brain-Computer Interfaces (BCIs)-Bio-inspired algorithms:-Ant Colony Optimization, Particle Swarm-Optimization, Genetic Algorithms-Central Pattern Generators (CPGs) for motion control.					<b>9</b>

<b>IV</b>	Bio-Inspired Robotics and Locomotion: Locomotion in biological systems: insects, birds, fish, humans-Legged, wheeled, and flying-robots inspired by nature-SLAM and Navigation using biologically inspired methods-Adaptive gait and control using bio-mechanical principles-Swarm Robotics: coordination strategies and communication.	<b>9</b>
<b>V</b>	Applications and Future Trends in Bionics: Prosthetics and wearable bio-robotics-Exoskeletons and rehabilitation robotics-Soft robotics and its biological inspiration-Implantable devices and human augmentation-Future challenges: integration with AI, sustainability, and ethics.	<b>9</b>

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Understand and explain the foundational principles of bionics and their role in bridging biology with robotics and AI.
<b>CO2</b>	Identify and implement bio-inspired sensors and actuators, analyzing their function in robotic and intelligent systems.
<b>CO3</b>	Apply bio-inspired computational models such as neural networks, evolutionary algorithms, and neuromorphic systems to solve engineering problems.
<b>CO4</b>	Design and evaluate robotic systems inspired by biological locomotion and swarm behavior for adaptive and intelligent movement.
<b>CO5</b>	Analyze real-world applications of bionics in areas like prosthetics, soft robotics, and human augmentation, while evaluating their ethical and technical implications.

### **Text Book:**

1. Dario Floreano & Claudio Mattiussi, “Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies”, MIT Press, 2008, ISBN: 9780262062718.
2. Yoseph Bar-Cohen, “Biomimetics: Nature-Based Innovation”, CRC Press (Taylor & Francis Group), 2011 (2nd Edition), ISBN: 9781439834763.

### **Reference Books:**

3. Barbara Mazzolai & Lucia Beccai, “Bioinspired Soft Robotics: Technologies and Applications”, CRC Press, 2022, ISBN: 9780367333341.
4. Ronald Arkin, “Behavior-Based Robotics”, MIT Press, 1998, ISBN: 9780262011655

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	1	0	1	0	0	1	0	1	0	2	2	2	2
<b>CO2</b>	3	2	3	1	3	0	0	0	0	1	0	1	3	3	2
<b>CO3</b>	3	3	3	2	2	0	0	1	1	1	0	2	2	3	3
<b>CO4</b>	3	2	3	1	3	1	1	1	2	2	2	2	3	3	3
<b>CO5</b>	2	2	1	1	1	3	3	3	1	2	1	2	2	2	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>			<b>BTAR</b>
<b>Course Code</b>	<b>25BTAR373</b>	<b>Number of Hours/Week</b>			<b>3</b>
<b>Semester</b>	<b>VII (DSE VII)</b>	<b>Max. Marks</b>			<b>100</b>
<b>Year</b>	<b>IV</b>	<b>Credits</b>			<b>3</b>
<b>Discipline Specific Elective</b>					
<b>Course Title</b>	<b>MICRO ELECTRO MECHANICAL SYSTEMS</b>			<b>L</b>	<b>T</b>
				<b>3</b>	<b>0 0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>					
<b>COURSE OBJECTIVES:</b>					
<b>The main learning objective of this course is to prepare the students to:</b>					
<ul style="list-style-type: none"> <li>• Comprehend the Fundamentals of Digital Marketing.</li> <li>• Develop Effective Content Marketing Strategies and Email Marketing Campaigns.</li> <li>• Understand and Implement Social Media Marketing Techniques and Display Marketing.</li> <li>• Develop Expertise in Search Engine Marketing (SEM) and Utilize Mobile Marketing.</li> <li>• Apply Analytics to Optimize Digital Marketing Strategies.</li> </ul>					
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>
<b>I</b>	Introduction to MEMS: Overview of MEMS, new trends in engineering and science, micro and nano scale systems, intrinsic characteristics of MEMS, elements of MEMS: micro sensors and micro actuators, microelectronics fabrication process, energy domains, materials for MEMS: silicon, polymers, metals; Packaging and integration: glass encapsulation, MEMS process integration strategies, applications of micro and nanoelectromechanical systems.				<b>9</b>
<b>II</b>	Fabrication Technologies: Surface micromachining: Sacrificial layer processes, micro motors; Bulk micromachining: micro needles, micro nozzles; Etching: dry etching, plasma etching; Wet etching: principle and process architect; High Aspect-Ratio Processes: LIGA process, Deep Reactive Ion Etching (DRIE); Thin film deposition: Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD); Evaporation and sputtering.				<b>9</b>
<b>III</b>	Mechanical concepts: Crystal planes and orientation, Internal force analysis, mechanical properties of silicon and related thin films, flexural beam bending analysis under simple loading conditions, torsional deflections, spring constant and resonant frequency. Electrical concepts: semiconductor materials, calculation of charge carrier concentration, conductivity and resistivity of semiconductor.				<b>9</b>

<b>IV</b>	Sensing and Actuation Techniques: 12 Lectures Micro sensors: Electrostatic sensor, principle of parallel plate capacitors and its applications, Thermal sensor: Fundamentals of thermal transfer, thermal bimorph principle, Piezoresistive sensor: Materials, piezoresistivity, Piezoelectric sensor: Materials and Piezoelectric effect, Micro actuators: Actuation using thermal forces, Actuation using shape memory alloys, Actuation using piezoelectric crystals, Actuation using electrostatic forces (Parallel plate, torsion bar), Actuation using electrostatic forces (Comb drive actuators), Micromechanical motors and pumps.	<b>9</b>
<b>V</b>	Case Studies of MEMS: MEMS inertial sensors in automobiles: airbag deployment, automobile navigation; MEMS vibratory gyroscope, MEMS accelerometer. MEMS devices in commercial applications: Inkjet printers, digital micromirror devices (DMD), radio frequency MEMS switches, scanning tunneling microscopes (STM)	<b>9</b>

### COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1</b>	Describe the fundamentals of Micro Electro Mechanical Systems (MEMS).
<b>CO2</b>	Explain standard micro fabrication techniques.
<b>CO3</b>	Discuss the mechanical and electrical behaviors of MEMS.
<b>CO4</b>	Discuss sensing and actuation techniques of MEMS system.
<b>CO5</b>	Summarize the applications of MEMS in real-world systems.

### Text Books:

1. Chang Liu, "Foundation of MEMS", 2nd edition, Pearson Education Inc., 2012.
2. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", 2nd edition, Tata McGraw Hill, 2008.

### Reference Books:

3. Reza Ghodssi, Pinyen, "MEMS Materials and Processes Handbook", Springer Science Business Media, 2011.
4. Rai-Choudhury P., "MEMS and MOEMS Technology and Applications", Prentice Hall of India Learning Private Limited, 2009.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	1	2	1	1	2	2	2	1	3	2	1	3	2	2	1
<b>CO2</b>	2	2	2	1	3	2	3	2	2	3	2	2	3	3	2
<b>CO3</b>	3	2	3	2	1	2	3	2	3	3	2	3	2	3	3
<b>CO4</b>	3	2	3	3	3	3	2	3	3	3	3	3	3	3	2
<b>CO5</b>	3	3	3	2	3	3	3	2	3	3	2	3	3	3	3

3 – High, 2 – Average, 1 – Low, 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR374</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VII (DSE VIII)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>IV</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>PATTERN RECOGNITION</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• To introduce the fundamental concepts of pattern recognition and machine learning.</li> <li>• To explore various feature extraction, classification, and clustering techniques.</li> <li>• To understand probabilistic models and deep learning approaches in pattern recognition.</li> <li>• To apply pattern recognition techniques to real-world problems.</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to Pattern Recognition</b> Definition and applications of Pattern Recognition-Design cycle of pattern recognition systems-Supervised vs. Unsupervised learning-Probability and statistical decision theory-Bayes Decision Theory and minimum error classification				<b>9</b>	
<b>II</b>	<b>Feature Extraction and Dimensionality Reduction</b> Feature types: Geometric, statistical, and symbolic features-Feature extraction techniques -PCA, LDA, ICA-Feature selection and ranking-Discriminant analysis and manifold learning-Introduction to Kernel methods				<b>9</b>	
<b>III</b>	<b>Classification Techniques</b> Nearest Neighbor Classifier (KNN)-Bayesian Classifiers -Naïve Bayes, Gaussian Bayes-Decision Trees and Random Forests-Support Vector Machines (SVM) Deep learning-based classification -CNNs, RNNs				<b>9</b>	
<b>IV</b>	<b>Clustering and Unsupervised Learning</b> Partition-based clustering: K-Means, K-Medoids-Hierarchical clustering: Agglomerative and Divisive-Density-based clustering: DBSCAN-Gaussian Mixture Models (GMM) and Expectation-Maximization (EM)-Self-Organizing Maps (SOM) and Fuzzy clustering				<b>9</b>	

<b>V</b>	<b>Applications of Pattern Recognition</b> Optical Character Recognition (OCR)-Speech and Face Recognition- Biometric Authentication -Fingerprint, Iris, Palm-print-Image- based object detection and recognition-Real-time applications in healthcare, finance, and security	<b>9</b>
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**Andragogy**

Class Room Lectures, Power point presentation, You Tube, Group Discussion, Seminar, Quiz, Formative Assessments, Brain storming, Activity

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Understand the fundamentals of pattern recognition and its real-world applications.
<b>CO2</b>	Perform feature extraction and dimensionality reduction techniques.
<b>CO3</b>	Implement classification techniques for supervised learning problems.
<b>CO4</b>	Apply clustering algorithms for unsupervised learning and pattern discovery.
<b>CO5</b>	Develop and evaluate pattern recognition models for industrial applications.

**Text Books:**

1. **"Pattern Recognition and Machine Learning"** – Christopher M. Bishop
2. **"Pattern Classification"** – Richard O. Duda, Peter E. Hart, and David G. Stork
3. **"Introduction to Machine Learning"** – Ethem Alpaydin

**Reference Books:**

1. **"Computer Vision: Algorithms and Applications"** – Richard Szeliski
2. **"Deep Learning"** – Ian Goodfellow, Yoshua Bengio, and Aaron Courville

**Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	2	1	1	2	1	3	3	2	2	3
CO2	3	3	3	3	3	2	2	2	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3
CO4	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3 – high, 2 – Average, 1 - Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR375</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VII (DSE VIII)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>IV</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>COMPUTATIONAL AND SYSTEMS BIOLOGY</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						

**COURSE OBJECTIVES:**

**The main learning objective of this course is to prepare the students to:**

- Explain fundamental concepts of computational and systems biology, including modeling, simulation, and analysis of biological systems. (Understanding)
- Utilize computational tools and programming languages (e.g., Python, R, MATLAB) to analyze biological datasets and develop predictive models. (Applying)
- Deconstruct complex biological networks and pathways to identify key components, interactions, and emergent behaviors. (Analyzing)
- Critically assess computational models and algorithms used in systems biology, comparing their effectiveness and limitations in biological research. (Evaluating)
- Design and implement a computational model to simulate a biological process, integrating experimental data for validation. (Creating).

<b>UNIT</b>	<b>TOPICS</b>	<b>HOURS</b>
<b>I</b>	<b>Introduction to Computational and Systems Biology</b> Overview of Systems Biology- Definitions, scope, and importance, Computational Approaches in Biology- Bioinformatics vs. Systems Biology, Molecular Networks- Genetic, protein, and metabolic networks, Mathematical Foundations- Graph theory, probability, and dynamical systems, High-Throughput Data- Genomics, transcriptomics, and proteomics, Tools & Software- Introduction to MATLAB, Python (Biopython, NumPy, SciPy), and R	<b>9</b>
<b>II</b>	<b>Mathematical and Computational Modeling of Biological Systems</b> Deterministic Models- Ordinary Differential Equations (ODEs) for gene regulation and metabolic pathways, Stochastic Models- Master equation, Gillespie algorithm for stochastic gene expression, Boolean Networks and Logical Models- Gene regulatory networks modeling, Parameter Estimation & Sensitivity Analysis- Optimization techniques (Gradient Descent, MCMC), Simulating Biological Systems- MATLAB/Python-based simulations	<b>9</b>

<b>III</b>	<b>Omics Data Analysis and Machine Learning in Biology</b> Next-Generation Sequencing (NGS) Data Analysis- RNA-Seq, ChIP-Seq, and variant calling, Gene Expression Analysis- Microarrays, clustering, and PCA, Machine Learning in Biology- Classification and clustering of biological data, Deep Learning Applications- Convolutional Neural Networks (CNNs) for bioimage analysis, Network Inference- Bayesian networks, correlation networks, and network reconstruction	<b>9</b>
<b>IV</b>	<b>Biological Networks and Systems Dynamics</b> Types of Biological Networks- Protein-protein interaction (PPI), gene regulatory, metabolic pathways, Network Analysis Techniques- Degree distribution, centrality measures, clustering, Dynamic Network Models- Time-series analysis of networks, Systems Biology Applications- Drug-target interaction prediction, disease modeling, Case Studies- Cancer systems biology, metabolic network modeling	<b>9</b>
<b>V</b>	<b>Synthetic Biology and Computational Drug Discovery</b> Synthetic Biology Principles- Engineering biological circuits, CRISPR-based design, Computational Drug Discovery- Molecular docking, structure-based drug design, Pharmacokinetics and Pharmacodynamics (PK/PD) Modeling, Multi-Omics Integration- Combining genomics, transcriptomics, and metabolomics, Future Trends in Computational and Systems Biology- AI in biology, single-cell analysis, personalized medicine	<b>9</b>

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	<b>Understand</b> fundamental concepts in computational and systems biology, including biological data analysis, modeling, and simulation.
<b>CO2</b>	<b>Apply</b> computational techniques and bioinformatics tools to analyze genomic, proteomic, and metabolomic data.
<b>CO3</b>	<b>Analyze</b> biological networks and systems dynamics using mathematical and computational models.
<b>CO4</b>	<b>Evaluate</b> different machine learning and statistical methods for biological data interpretation and decision-making.
<b>CO5</b>	<b>Create</b> computational models and simulations to study complex biological systems and predict biological behavior.

### **Text Books:**

1. Raman K. An introduction to computational systems biology: systems-level modelling of cellular networks. Chapman and Hall/CRC; 2021 May 30.

### **Reference Books:**

1. Huang T, MARTON, Computational Systems Biology. Huang T, editor. Springer Science+ Business Media, LLC, part of Springer Nature; 2018.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>	<b>3</b>
<b>CO2</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>3</b>

CO3	3	1	2	0	0	0	0	0	0	0	0	0	1	2	1
CO4	0	0	2	0	1	0	0	0	3	0	0	0	1	1	0
CO5	0	0	1	0	0	0	0	0	0	1	0	1	2	2	0

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>			<b>BTAR</b>		
<b>Course Code</b>	<b>25BTAR376</b>	<b>Number of Hours/Week</b>			<b>3</b>		
<b>Semester</b>	<b>VII (DSE VIII)</b>	<b>Max. Marks</b>			<b>100</b>		
<b>Year</b>	<b>IV</b>	<b>Credits</b>			<b>3</b>		
<b>Discipline Specific Elective</b>							
<b>Course Title</b>	<b>DIGITAL MARKETING</b>				<b>L</b>	<b>T</b>	<b>P</b>
					<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>							
<b>COURSE OBJECTIVES:</b>							
<b>The main learning objective of this course is to prepare the students to:</b>							
<ul style="list-style-type: none"> <li>• Comprehend the Fundamentals of Digital Marketing.</li> <li>• Develop Effective Content Marketing Strategies and Email Marketing Campaigns.</li> <li>• Understand and Implement Social Media Marketing Techniques and Display Marketing.</li> <li>• Develop Expertise in Search Engine Marketing (SEM) and Utilize Mobile Marketing.</li> <li>• Apply Analytics to Optimize Digital Marketing Strategies.</li> </ul>							
<b>UNIT</b>	<b>TOPICS</b>					<b>HOURS</b>	
<b>I</b>	<b>Introduction to Digital Marketing:</b> Fundamentals of Digital marketing & Its Significance, Traditional marketing Vs Digital Marketing, Evolution of Digital Marketing. Opportunities for building Brand Website – Planning and Creation – Marketing strategies for the digital world-latest practices.					<b>9</b>	
<b>II</b>	<b>Content and Email Marketing:</b> Content Marketing: Step-by-step Content Marketing, Developing a content marketing strategy. Email Marketing: Types of Emails in email marketing- Email Automation-Integrating Email with social media and Mobile.					<b>9</b>	
<b>III</b>	<b>Social Media Marketing and Display Marketing:</b> Social Media Marketing- Social Media Marketing Channels-Leveraging media for brand conversations and buzz. Successful/benchmark social media campaigns. Display Advertising: Working of Display Advertising; Benefits and challenges; Overview of Display ad Process.					<b>9</b>	

<b>IV</b>	<b>Search Engine and Mobile Marketing:</b> Introduction of SEM: How Search Engine works - SEM components. Search Engine Optimization: Keyword Strategy- SEO Strategy- SEO success factors-On Page Techniques-Off Page Techniques -PPC advertising. Mobile Marketing- Mobile Inventory/channels- Location based; Context based; Coupons and offers, Mobile Apps, Mobile Commerce, SMS Campaigns-Profiling and targeting.	<b>9</b>
<b>V</b>	<b>Digital Innovation and Trends:</b> The contemporary digital revolution, digital transformation and Channel Attribution, security and privatization issues with digital marketing. Analytics- Ad-words, Email, Mobile, social media, Web Analytics – Changing your strategy based on analysis- Recent trends in Digital marketing.	<b>9</b>

### COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1</b>	Understand the Fundamentals and Evolution of Digital Marketing
<b>CO2</b>	Develop and Implement Content and Email Marketing Techniques.
<b>CO3</b>	Leverage Social Media Marketing for Brand Growth and Gain Expertise in Display Advertising.
<b>CO4</b>	Develop Skills in Search Engine Marketing (SEM) and Utilize Mobile Marketing Techniques.
<b>CO5</b>	Understand Digital Innovation and Emerging Trends

### Text Books:

1. Mouty Maiti: Internet Marketing, Oxford University Press India
2. Vandana, Ahuja; Digital Marketing, Oxford University Press India (November, 2015).
3. Eric Greenberg, and Kates, Alexander; Strategic Digital Marketing: Top Digital Experts Share the Formula for Tangible Returns on Your Marketing Investment; McGraw-Hill Professional (October, 2013).
4. Ryan, Damian; Understanding Digital Marketing: marketing strategies for engaging the digital generation; Kogan Page (3rd Edition, 2014).
5. Tracy L. Tuten & Michael R. Solomon: Social Media Marketing (Sage Publication)

### Reference Books:

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Computer Algorithms/ C++, Second Edition, Universities Press, 2019.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, Third Edition, PHI Learning Private Limited, 2012.
3. S. Sridhar, Design and Analysis of Algorithms, Oxford university press, 2014.
4. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education, Reprint 2006.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>

CO2	2	2	2	1	3	2	3	2	2	3	2	2	3	3	2
CO3	3	2	3	2	1	2	3	2	3	3	2	3	2	3	3
CO4	3	2	3	3	3	3	2	3	3	3	3	3	3	3	2
CO5	3	3	3	2	3	3	3	2	3	3	2	3	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>			<b>BTAR</b>		
<b>Course Code</b>	<b>25BTAR271</b>	<b>Number of Hours/Week</b>			<b>2</b>		
<b>Semester</b>	<b>VII</b>	<b>Max. Marks</b>			<b>100</b>		
<b>Year</b>	<b>IV</b>	<b>Credits</b>			<b>1</b>		
<b>Core Course</b>							
<b>Course Title</b>	<b>ROBOT DYNAMICS AND TRAJECTORY PLANNING LAB</b>				<b>L</b>	<b>T</b>	<b>P</b>
					<b>0</b>	<b>0</b>	<b>2</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>							
<b>COURSE OBJECTIVES:</b>							
<ul style="list-style-type: none"> <li>• <b>Introduce</b> the fundamentals of robotics, including components, degrees of freedom, and spatial transformations.</li> <li>• <b>Develop</b> an understanding of manipulator kinematics, inverse kinematics, and Jacobian analysis.</li> <li>• <b>Provide</b> knowledge of manipulator dynamics, velocities, and static forces using Newton-Euler and Lagrangian methods.</li> <li>• <b>Enable</b> the design and analysis of manipulator mechanisms, actuation systems, and motion control.</li> <li>• <b>Teach</b> trajectory and motion planning, focusing on kinematic models, constraints, and advanced planning technique</li> </ul>							
<b>LIST OF EXPERIMENTS</b>							
<ol style="list-style-type: none"> <li>1. Spatial Transformation and Frame Mapping using MATLAB</li> <li>2. Forward Kinematics Simulation of a 3-DOF Planar Manipulator</li> <li>3. Inverse Kinematics Solution for a 3R Robot Arm</li> <li>4. Jacobian Matrix Computation and Velocity Analysis</li> <li>5. Static Force Analysis Using the Jacobian Transpose Method</li> <li>6. Dynamic Modeling of a 2-Link Manipulator Using Lagrange's Equations</li> <li>7. PID Controller Design for Joint Position Control</li> <li>8. Trajectory Planning in Joint Space Using Cubic Polynomials</li> <li>9. Obstacle Avoidance Motion Planning Using Potential Field Method</li> <li>10. Closed-Loop Motion Control Simulation with State-Space Controller</li> </ol>							

### COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1</b>	Understand robot components, spatial descriptions, and transformations in mechanics and control.
<b>CO2</b>	Analyze manipulator kinematics, including inverse kinematics and Jacobian matrices.

<b>CO3</b>	Apply manipulator dynamics and calculate velocities and static forces in robotic systems.
<b>CO4</b>	Design manipulator mechanisms and use motion control systems with transfer functions.
<b>CO5</b>	Plan and implement robot trajectories, considering motion constraints and planning techniques

### Mapping of Course Outcomes (CO's) with PO's & PSO's

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	3	2	3	2	3	1	3	2	1	3	2	3
CO2	2	3	1	2	3	2	3	1	3	2	3	2	1	3	2
CO3	1	2	3	2	1	3	2	3	2	3	1	3	2	3	1
CO4	3	2	1	3	2	1	3	2	3	1	2	3	3	1	2
CO5	2	3	2	1	3	2	1	3	2	3	2	1	3	2	3

3 – high, 2 – Average, 1 - Low , 0-Null

# **Semester VIII**

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR381</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VIII (DSE IX)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>IV</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>MOBILE, MICRO AND NANO ROBOTICS</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• Understand the fundamental tasks, challenges, and environments of mobile robots, including tele-robotics and service robotics.</li> <li>• Explore the kinematics and dynamics of various mobile robots, including wheeled, legged, aerial, and underwater robots.</li> <li>• Analyze sensors for localization and navigation, including position sensors, gyroscopes, and visual systems.</li> <li>• Learn about localization, mapping, and motion control strategies for mobile robots.</li> <li>• Investigate micro-robotics principles, fabrication, applications, and micro-assembly technologies</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	Introduction to Mobile Robots - Tasks of mobile robots, robots manufacturers, type of obstacles and challenges, tele-robotics, philosophy of robotics, service robotics, types of environment representation. Ground Robots: Wheeled and Legged Robots, Aerial Robots, Underwater Robots and Surface Robots.				<b>9</b>	
<b>II</b>	Kinematics and Dynamics of Wheeled Mobile Robots (two, three, four - wheeled robots, omnidirectional and macanum wheeled robots). Sensors for localization: magnetic and optic position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, GNSS and Sensors for navigation: tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual system.				<b>9</b>	
<b>III</b>	Localization and Mapping in mobile robotics. Motion Control of Mobile Robots (Model and Motion based Controllers): Lyapunov-based Motion Control Designs and Case Studies. Understand the current application and limitations of Mobile Robots. Introduction to Mobile Manipulators and Cooperative Mobile Robots.				<b>9</b>	

<b>IV</b>	Micro-robotics: Introduction, Task specific definition of micro-robots - Size and Fabrication Technology based definition of micro-robots - Mobility and Functional-based definition of microrobots - Applications for MEMS based micro-robots. Implementation of Micro-robots: Arrayed actuator principles for micro-robotic applications – Micro-robotic actuators.	<b>9</b>
<b>V</b>	Design of locomotive micro-robot devices based on arrayed actuators. Micro-robotics devices: Micro- grippers and other micro-tools - Micro-conveyors - Walking MEMS Micro-robots – Multirobot system: Micro-robot powering, Micro-robot communication. Microfabrication and Microassembly: Micro-fabrication principles - Design selection criteria for micromachining – Packaging and Integration	<b>9</b>

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Recognize the challenges and opportunities in designing and deploying mobile robots in diverse environments.
<b>CO2</b>	Apply knowledge of kinematics, dynamics, and sensors to design and control mobile robots effectively.
<b>CO3</b>	Demonstrate understanding of motion control models and Lyapunov-based controllers for mobile robots.
<b>CO4</b>	Evaluate the implementation and applications of micro-robots, including MEMS-based systems.
<b>CO5</b>	Develop insights into microfabrication, micro-assembly, and multi-robot communication technologies

**Text Books:**

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Sacramuzza, Introduction to Autonomous Mobile Robots, MIT press, 2nd edition, 2011.
2. Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, LydiaKavraki, and Sebastian Thrun, – Principles of Robot Motion-Theory, Algorithms, and Implementation, MIT Press, Cambridge, 2005.

**Reference Books:**

1. Atnaik, Srikanta, "Robot Cognition and Navigation: An Experiment with Mobile Robots", Springer-Verlag Berlin and Heidelberg, 2007.
2. Spyros G. Tzafestas, "Introduction to Mobile Robot Control", Elsevier, 2021.

**Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
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CO1	3	3	2	2	3	2	3	2	1	2	1	3	2	3	2
CO2	3	3	3	2	3	2	3	2	2	2	1	3	3	3	2
CO3	3	3	3	3	3	2	2	2	1	3	1	3	3	3	3
CO4	3	3	2	3	3	2	2	2	1	2	2	3	2	3	3
CO5	3	3	3	3	3	2	3	2	2	3	3	3	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>			<b>BTAR</b>
<b>Course Code</b>	<b>25BTAR382</b>	<b>Number of Hours/Week</b>			<b>3</b>
<b>Semester</b>	<b>VIII (DSE IX)</b>	<b>Max. Marks</b>			<b>100</b>
<b>Year</b>	<b>IV</b>	<b>Credits</b>			<b>3</b>
<b>Discipline Specific Elective</b>					
<b>Course Title</b>	<b>INTELLIGENT MANUFACTURING</b>				<b>L</b>
					<b>T</b>
					<b>P</b>
				<b>3</b>	<b>0</b>
				<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>					
<b>COURSE OBJECTIVES:</b>					
<b>The main learning objective of this course is to prepare the students:</b>					
<ul style="list-style-type: none"> <li>To familiarize students with the evolution of manufacturing systems and the foundational concepts of intelligent manufacturing.</li> <li>To introduce students to the application of artificial intelligence and machine learning in manufacturing environments.</li> <li>To equip students with knowledge of IIoT architectures, data communication protocols, and cyber-physical systems.</li> <li>To provide students with an understanding of intelligent robotic systems and their integration into flexible manufacturing environments.</li> <li>To expose students to real-world implementations and challenges of intelligent manufacturing through case studies.</li> </ul>					
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>
<b>I</b>	<b>Introduction to Intelligent Manufacturing Systems:</b> Evolution of manufacturing paradigms: Craft production, Mass production, Lean, Agile, and Intelligent manufacturing-Definition and scope of Intelligent Manufacturing-Key Enabling Technologies: AI, IoT, Big- Data, Robotics, Cloud Computing-Comparison with conventional manufacturing systems-Smart factory concept and Cyber-Physical Systems (CPS).				<b>9</b>
<b>II</b>	<b>Artificial Intelligence and Machine Learning in Manufacturing:</b> Role of AI and ML in manufacturing-Machine learning algorithms for predictive maintenance, quality control, and process optimization-Knowledge-based systems and expert systems-Case studies on intelligent defect detection, fault diagnosis, and adaptive process control-Intelligent decision-making systems.				<b>9</b>
<b>III</b>	<b>Industrial Internet of Things (IIoT) and Cyber Physical Systems:</b> Architecture and protocols of IIoT-Sensor networks and data acquisition-Edge, fog, and cloud computing in manufacturing-Digital twin technology and its integration with CPS-Real-time data analytics and interoperability				<b>9</b>

<b>IV</b>	<b>Intelligent Robotics and Flexible Automation:</b> Overview of industrial robotics and collaborative robots (cobots) Intelligent control of robots: machine vision, sensor integration-Flexible manufacturing systems (FMS)-Autonomous mobile robots (AMRs) in smart factories-Human-robot interaction (HRI).	<b>9</b>
<b>V</b>	<b>Intelligent manufacturing applications:</b> Applications, Case Studies, and Future Trends: Smart factories and Industry 4.0 implementations-Case studies from automotive, aerospace, electronics, and healthcare- sustainability and green manufacturing-Ethical considerations and challenges in intelligent manufacturing-Emerging trends: Industry 5.0, hyper-automation, digital manufacturing ecosystems.	<b>9</b>

### COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1</b>	Infer the principles and evolution of intelligent manufacturing systems from traditional paradigms.
<b>CO2</b>	Execute AI and ML techniques for fault detection, quality prediction, and process optimization in manufacturing.
<b>CO3</b>	Implement IIoT-based architectures and data-driven control systems using cyber-physical concepts.
<b>CO4</b>	Validate and integrate intelligent robotic systems within flexible manufacturing environments.
<b>CO5</b>	Develop innovative solutions for sustainable and ethical intelligent manufacturing aligned with industry trends.

1. Jay Lee, Behrad Bagheri, Hung-An Kao, Industrial AI,, Springer, 2020.
2. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson.
3. David Jin, Sally Lin, Advances in Intelligent and Soft Computing, Springer.
4. Research papers and case studies from IEEE, Springer, Elsevier on Intelligent Manufacturing and Industry 4.0.

### Reference Books

1. Sabina Jeschke, Christian Brecher, Tobias Meisen, Industrial Internet of Things and Cyber-Physical Systems: Transforming the Manufacturing Industry, Springer, 2017.
2. S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley India.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	2	2	2	1	2	1	3	2	2	2
CO2	3	3	3	3	3	1	2	1	2	2	2	3	3	3	3
CO3	3	2	3	2	3	2	2	1	2	2	3	3	3	3	3
CO4	3	2	3	2	3	2	2	2	3	2	3	3	3	3	3
CO5	3	3	2	2	2	3	3	3	2	3	3	3	2	2	3

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR383</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VIII (DSE IX)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>IV</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>GPU COMPUTING</b>			<b>L</b>	<b>T</b>	<b>P</b>
				<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students to:</b>						
<ul style="list-style-type: none"> <li>• <b>Understand</b> the architecture and programming model of modern GPUs. (Remembering, Understanding)</li> <li>• <b>Learn</b> parallel computing concepts and how to optimize performance using GPU acceleration. (Understanding, Applying)</li> <li>• <b>Develop</b> CUDA-based parallel programs to solve computationally intensive problems. (Applying, Analyzing)</li> <li>• <b>Analyze</b> the efficiency of parallel algorithms and their execution on GPU hardware. (Analyzing, Evaluating)</li> <li>• <b>Optimize</b> and <b>implement</b> real-world applications using GPU computing techniques. (Evaluating, Creating).</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Introduction to GPU Computing</b> Evolution of parallel computing, Introduction to GPUs and their architecture, CPU vs GPU- Parallelism and Performance Benefits, Overview of CUDA and OpenCL, Applications of GPU computing in scientific computing, AI, and gaming.				<b>9</b>	
<b>II</b>	<b>CUDA Programming Basics</b> Introduction to CUDA programming model, CUDA architecture- Threads, Blocks, and Grids, Memory hierarchy- Global, Shared, and Local memory, CUDA programming- Kernel functions and launching mechanisms, Synchronization and performance considerations.				<b>9</b>	
<b>III</b>	<b>Advanced CUDA and Optimization</b> Memory optimization techniques, CUDA streams and concurrency, Use of shared memory for performance improvement, Profiling and debugging CUDA applications, Introduction to Thrust library.				<b>9</b>	

<b>IV</b>	<b>OpenCL and Alternative GPU Frameworks</b> OpenCL architecture and execution model, Writing OpenCL kernels and host programs, Comparing CUDA and OpenCL, Introduction to Vulkan and Metal for GPU computing, Multi-GPU programming and interoperability.	<b>9</b>
<b>V</b>	<b>Applications and Emerging Trends</b> GPU acceleration in Deep Learning and AI (TensorFlow, PyTorch), Scientific computing and high-performance simulations, Real-time rendering and ray tracing, Introduction to Quantum Computing with GPUs, Future trends in GPU architectures.	<b>9</b>

### **COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

<b>CO1</b>	Describe the fundamentals of GPU architecture and parallel computing models.
<b>CO2</b>	Explain the CUDA programming model and its application in GPU computing.
<b>CO3</b>	Implement CUDA programs for solving parallelizable problems.
<b>CO4</b>	Evaluate the performance of GPU-accelerated programs and optimize computation efficiency.
<b>CO5</b>	<b>Design and develop</b> GPU-based solutions for real-world scientific and engineering applications.

### **Text Books:**

1. Bandyopadhyay, Avimanyu. Hands-On GPU Computing with Python: Explore the capabilities of GPUs for solving high performance computational problems. Packt Publishing Ltd, 2019.

### **Reference Books:**

1. Tuomanen, Brian. Hands-On GPU Programming with Python and CUDA: Explore high-performance parallel computing with CUDA. Packt Publishing Ltd, 2018.

### **Mapping of Course Outcomes (CO's) with PO's & PSO's**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	1	0	2	0	2	0	0	1	0	0	0	1	0	0	0
<b>CO2</b>	1	2	0	0	0	1	2	0	3	0	1	2	2	1	3
<b>CO3</b>	2	0	0	0	0	0	2	0	0	0	0	1	2	2	1
<b>CO4</b>	2	2	2	0	1	2	0	0	3	0	0	1	1	0	0
<b>CO5</b>	2	0	2	0	0	1	0	1	0	0	0	0	0	2	1

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>	<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR384</b>	<b>Number of Hours/Week</b>	<b>3</b>			
<b>Semester</b>	<b>VIII (DSE X)</b>	<b>Max. Marks</b>	<b>100</b>			
<b>Year</b>	<b>IV</b>	<b>Credits</b>	<b>3</b>			
<b>Discipline Specific Elective</b>						
<b>Course Title</b>	<b>SPECIAL INTELLIGENT MACHINE</b>			<b>L</b>	<b>T</b>	<b>P</b>
			<b>3</b>	<b>0</b>	<b>0</b>	
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>						
<b>COURSE OBJECTIVES:</b>						
<b>The main learning objective of this course is to prepare the students:</b>						
<ul style="list-style-type: none"> <li>• Understand the basics of artificial intelligent</li> <li>• Explain the concepts of searching</li> <li>• Analyze the local agents</li> <li>• Interfere about Natural language processing</li> <li>• Applications of artificial intelligent</li> </ul>						
<b>UNIT</b>	<b>TOPICS</b>				<b>HOURS</b>	
<b>I</b>	<b>Artificial Intelligent</b> – Introduction – What is AI? – The foundations of AI – The history of AI – The state of the Art. <b>Intelligent Agents:</b> Agents and Environments – Good behaviour – The nature of environment – The structure of Agents.				<b>9</b>	
<b>II</b>	<b>Problem solving: Solving problems by Searching</b> – Problem-solving agents – Example problems – Searching for solutions – Uninformed search strategies - Informed search strategies – Heuristic Functions – <b>Beyond classical search:</b> Local search algorithms – Local search in continuous spaces – Searching with nondeterministic actions – Searching with partial observations – online search agents				<b>9</b>	
<b>III</b>	<b>Knowledge, reasoning and planning: Logical Agents:</b> Knowledge based agents – The Wumpus world – Logic – Propositional Logic – Propositional theorem proving – Effective propositional model checking – Agents based on propositional logic.				<b>9</b>	

<b>IV</b>	<b>Communicating, perceiving and acting: Natural Language Processing</b> – Language Models – Text classification – Information retrieval – Information extraction. <b>Natural language for communication:</b> Phrase structure grammars – Syntactic analysis – Augmented grammars – Machine translations – Speech recognition	<b>9</b>
<b>V</b>	<b>Robotics</b> – Introduction – Robot hardware – Robot perception – Planning to move – Planning uncertain movements – Moving – Robotic software architectures – Application domains.	<b>9</b>

### COURSE OUTCOMES:

On successful completion of this course, the student will be able to

<b>CO1</b>	Understand the basics of artificial intelligent
<b>CO2</b>	Explain the concepts of searching
<b>CO3</b>	Analyze the local agents
<b>CO4</b>	Interfere about Natural language processing
<b>CO5</b>	Applications of artificial intelligent

### Text Book

1. Artificial Intelligence: A Modern Approach 3E, Stuart J. Russell and Peter Norvig, Prentice hall, Pearson, 2010

### Reference Books

1. Superintelligence, Paths, Dangers, Strategies, Nick Bostrom, OUP Oxford, 2014
2. Artificial Intelligence: A Guide for Thinking, Melanie Mitchell, Farrar, Straus and Giroux, 2019

### Mapping of Course Outcomes (CO's) with PO's & PSO's

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	2	2	3	2	2	3	2	2	3	2	2	2	2	2
<b>CO2</b>	3	3	3	2	3	2	3	3	3	2	3	2	2	2	2
<b>CO3</b>	3	3	2	3	2	2	3	3	2	3	2	2	3	3	2

CO4	3	2	2	3	1	2	3	2	2	3	1	2	3	3	2
CO5	3	2	2	2	1	2	3	2	2	2	1	2	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>			<b>BTAR</b>			
<b>Course Code</b>	<b>25BTAR385</b>	<b>Number of Hours/Week</b>			<b>3</b>			
<b>Semester</b>	<b>VIII (DSE X)</b>	<b>Max. Marks</b>			<b>100</b>			
<b>Year</b>	<b>IV</b>	<b>Credits</b>			<b>3</b>			
<b>Discipline Specific Elective</b>								
<b>Course Title</b>	<b>WEB DATA MINING</b>					<b>L</b>	<b>T</b>	<b>P</b>
						<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>								
<b>COURSE OBJECTIVES:</b>								
<b>The main learning objective of this course is to prepare the students to:</b>								
<ul style="list-style-type: none"> <li>• <b>Understand Data Mining Concepts and Functionalities:</b> Learn the foundational principles of data mining, including pre-processing techniques like cleaning, integration, reduction, and discretization, along with the architecture and classification of data mining systems.</li> <li>• <b>Explore Association Rule Mining:</b> Study efficient algorithms for frequent item set mining, discover various types of association rules, and perform correlation and constraint-based analysis for meaningful data insights.</li> <li>• <b>Master Classification and Prediction Techniques:</b> Analyze methods like decision trees, Bayesian classifiers, backpropagation, support vector machines, and ensemble techniques to develop accurate classification and prediction models.</li> <li>• <b>Analyze Clustering Techniques and Outlier Detection:</b> Examine clustering methods, such as partitioning, hierarchical, density-based, and model-based techniques, and apply these methods to high-dimensional data and outlier analysis.</li> <li>• <b>Mine Complex Data Types:</b> Explore multidimensional analysis and mining techniques for complex data objects, including spatial, multimedia, text, and web data, for advanced data mining applications.</li> </ul>								
<b>UNIT</b>	<b>TOPICS</b>						<b>HOURS</b>	
<b>I</b>	<b>Introduction:</b> Basic Data Mining Tasks – Data Mining Versus Knowledge Discovery in Data Bases – Data Mining Issues – Data Mining Matrices – Social Implications of Data Mining – Data Mining from Data Base Perspective.						<b>9</b>	

<b>II</b>	<b>Neural Networks:</b> Data Mining Techniques – a Statistical Perspective on data mining – Similarity Measures – Decision Trees – Neural Networks – Genetic Algorithms.	<b>9</b>
<b>III</b>	<b>Fuzzy Systems</b> Classification: Introduction – Statistical – Based Algorithms – Distance Based Algorithms – Decision.	<b>9</b>
<b>IV</b>	<b>Genetic Algorithm:</b> Clustering Tree – Based Algorithms – Neural Network Based Algorithms – Rule Based Algorithms – Combining Techniques: Introduction – Similarity and Distance Measures –Outliers – Hierarchical Algorithms. Partitioned Algorithms.	<b>9</b>
<b>V</b>	<b>Hybrid Systems:</b> Association Rules: Introduction - Large Item Sets – Basic Algorithms – Parallel & Distributed Algorithms – Comparing Approaches – Incremental Rules – Advanced Association Rules Techniques – Measuring the Quality of Rules.	<b>9</b>

### Course Outcomes

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

<b>CO1</b>	Understanding Data Mining Techniques and Their Applications
<b>CO2</b>	Mastery of Machine Learning Algorithms for Data Mining
<b>CO3</b>	Critical Analysis of Data Mining Issues and Social Implications
<b>CO4</b>	Expertise in Hybrid and Combined Data Mining Approaches
<b>CO5</b>	Application of Data Mining Techniques for Real-World Problems

### Text Books:

1. Jiawei Han & Micheline Kamber, “Data Mining Concepts & Techniques”, 2011, 3rd Edition.

### Reference Books:

1. Margaret H. Dunham, “Data Mining Introductory and Advanced Topics”, Pearson, Education 2003.

### Mapping of Course Outcomes (CO's) with PO's & PSO's

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO1</b>	3	3	2	2	3	2	2	1	3	2	2	1	3	2	2
<b>CO2</b>	3	3	3	2	3	3	2	2	3	3	3	2	3	3	3
<b>CO3</b>	2	2	3	3	2	3	3	2	3	2	3	2	2	3	2

CO4	3	3	2	3	3	3	3	3	3	3	2	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3 – High, 2 – Average, 1 – Low , 0-Null

<b>Programme</b>	<b>B.Tech CSE (AI &amp; RO)</b>	<b>Programme Code</b>			<b>BTAR</b>		
<b>Course Code</b>	<b>25BTAR386</b>	<b>Number of Hours/Week</b>			<b>3</b>		
<b>Semester</b>	<b>VIII (DSE X)</b>	<b>Max. Marks</b>			<b>100</b>		
<b>Year</b>	<b>IV</b>	<b>Credits</b>			<b>3</b>		
<b>Discipline Specific Elective</b>							
<b>Course Title</b>	<b>GENERATIVE AI</b>				<b>L</b>	<b>T</b>	<b>P</b>
					<b>3</b>	<b>0</b>	<b>0</b>
<b>L-Lecture Hours T-Tutorial Hours P-Practical Hours</b>							
<b>COURSE OBJECTIVES:</b>							
<b>The main learning objective of this course is to prepare the students:</b>							
<ul style="list-style-type: none"> <li>• To explore classical and advanced concepts in generative AI</li> <li>• To equip different generative models in modern AI</li> <li>• To construct an existing problem into standard machine learning paradigm</li> <li>• To dealt with generative models for scalable machine learning.</li> </ul>							
<b>UNIT</b>	<b>TOPICS</b>						<b>HOURS</b>
<b>I</b>	<b>Introduction</b> Introduction – artificial intelligence, machine learning, deep learning; intelligent agent and its environment; state space searches; informed and informed searches; adversarial searches; supervised and unsupervised learning; discriminative AI – classification, regression, clustering, dimensionality reduction, reinforcement learning;						<b>9</b>
<b>II</b>	<b>Generative AI</b> Data generation; data transformation; data enrichment; boltzmann machines; gibbs sampling; restricted boltzmann machines; deep belief networks; deep boltzmann machines; autoencoders; varioational autoencoders; generative adversarial networks (GANs)						<b>9</b>

<b>III</b>	<b>Modern Generative AI</b> Nash equilibrium; GANs applications – generating realistic images, image to image translation, super resolution, data augmentation, style transfer; contrastive language-image pretraining (CLIP); diffusion models; stable diffusion Tech; midjourney; autoregression;	<b>9</b>
<b>IV</b>	<b>Large Language Models</b> Markov chains; rule based text generation; recurrent neural networks; long short-term memory networks; N-gram models; seq2seq; GAN for text generation; Transformers; tokenization; pretraining and fine tuning LLMs; prompt engineering; GPTs	<b>9</b>
<b>V</b>	<b>Ethical concerns and social implications</b> Bias and fairness in AI generated data; data privacy, safety, security; mis information and misuse of generative AI; generative AI’s impact on jobs and industry; dependency on AI; environmental concerns; AI oversight and self regulations; multi tasking and multi sensory generative AI	<b>9s</b>

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to:

<b>CO1</b>	Infers classical generative algorithms in AI
<b>CO2</b>	Execute classical ML approaches into generative machine learning
<b>CO3</b>	Implement generative models for ML applications
<b>CO4</b>	Validate the ML models to improve the performance
<b>CO5</b>	Develop an innovative generative AI model for existing problems

**Text Books:**

1. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach. Prentice Hall Press, USA, 3rd edition, 2009
2. Martin musiol. Generative AI. Wiley publications. 2024.

**Mapping of Course Outcomes (CO’s) with PO’s & PSO’s**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	0	1	0	0	0	1	0	3	0	1	2
CO2	3	2	1	3	1	0	2	0	0	1	0	2	1	2	3
CO3	3	2	2	3	3	2	3	0	0	2	0	2	2	2	3
CO4	2	3	1	2	3	1	2	1	1	1	1	2	2	1	3
CO5	3	2	3	3	3	2	3	3	3	2	2	2	3	3	3

3 – high, 2 – Average, 1 - Low , 0-Null

