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UNIVERSITY OF PETROLEUM & ENERGY STUDIES

School of Computer Science

Dehradun

COURSE PLAN

Programme : B.Tech (CSE+AIML)

Course : Algorithm for Intelligent Systems and Robotics

Subject Code : CSAI 2004

No. of credits : 2

Semester : V

Session : Aug 2023- Dec 2023

Batch : 2021-2025

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COURSE PLAN

A. **PREREQUISITE:**

a. Basic Knowledge of designing algorithm, machine learning and microprocessor
b. Basic knowledge of logical interpretation and Python programming language

B. PROGRAM OUTCOMES (POs) and PROGRAM SPECIFIC OUTCOMES (PSOs) for Algorithm for Intelligent Systems and Robotics:

B1. PROGRAM OUTCOMES (POs)

Engineering Graduates will 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 analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

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

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

B2. Program Specific Outcomes (PSOs)

Computer Science Engineering with specialization in AI/ML Graduates will be able to:

PSO1. Perform system and application programming using computer system concepts, concepts of Data Structures, algorithm development, problem solving and optimizing techniques,

PSO2. Apply software development and project management methodologies using concepts of front-end and back-end development and emerging technologies and platforms.

PSO3. Ability to create & develop most efficient solutions by applying machine learning with analytical emphasis on industrial and research problems.

C. COURSE OUTCOMES FOR Algorithm for Intelligent Systems and Robotics: At the end of this course student should be able to

CO1.To discuss the basic concepts of algorithms for intelligent systems and robotics.
CO2. To use of different types of sensors, tactile, proximity, range etc.
CO3. To discuss basic understanding of intelligent machines supported by kinematics and mechanics.

Table: Correlation of POs and PSOs v/s COs

Course Outcomes	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	1								2		2
CO2	2	2	1	2	2								2		3
CO3	2	2	1	2	2								2		2
Average	2	2	1	2	1.66								2		2.33

1= Weak 2= Moderate 3=Strong

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Perform system and application programming using computer system concepts, concepts of Data Structures, algorithm development, problem solving and optimizing techniques	Apply software development and project management methodologies using concepts of front-end and back-end development and emerging technologies and platforms.	Ability to develop the understanding of quantitative modeling and data analysis techniques and to apply these to real world business problems, communicate findings, and effectively present results for improved decision-making.
Course Code	Course Title	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CSAI2004	Algorithm for Intelligent Systems and Robotics	2	2	1	2	1.66								2		2.33

1= Weak 2= Moderate 3=Strong

D. PEDAGOGY

- **Presentation,**
- **Voiceover Presentation & Video lectures,**
- **NPTEL videos,**
- **YouTube videos.**

E. COURSE COMPLETION PLAN

Total Class room sessions	24
Total Test	01
Total Assignment	02

One Session =60 minutes

F. EVALUATION & GRADING

Students will be evaluated based on the following 3 stages.

5.1	Internal Assessment	-	30%
5.2	Mid-term Examination	-	20%
5.2	End term Examination	-	50%

H1. INTERNAL ASSESSMENT: WEIGHTAGE – 30%

Internal Assessment shall be done based on the following:

Sl. No.	Description	% of Weightage out of 30%
1	Class Tests	50%
2	Assignments (Problems/Presentations)	20%
3	Attendance and conduct in the class and concept diary	30%

H2*. Internal Assessment Record Sheet (including Mid Term Examination marks)* *will be displayed online at the end of semester i.e. last week of regular classroom teaching.*

H3. CLASS TESTS/QUIZZES: Two Class Tests based on descriptive type theoretical & numerical questions and Two Quizzes based on objective type questions will be held; one class test and one quiz at least ten days before the Mid Term Examination and second class test and second quiz at least ten days before the End Term Examination. Those who do not appear in Viva-Voce and quiz examinations shall lose their marks.

The marks obtained by the students will be displayed on LMS a week before the start of Mid Term and End Term Examinations respectively.

H4. ASSIGNMENTS: After completion of each unit or in the mid of the unit, there will be home assignments based on theory and numerical problems. Those who fail to submit the assignments by the due date shall lose their marks.

H5. GENERAL DISCIPLINE: Based on student's regularity, punctuality, sincerity and behavior in the class.

The marks obtained by the students will be displayed on LMS at the end of semester.

H6. MID TERM EXAMINATION: WEIGHTAGE – 20%

Mid Term examination shall be Two Hours duration and shall be a combination of Short and Long theory Questions.

Date of showing Mid Term Examination Answer Sheets: Within a week after completion of mid Sem examination.

H7. END TERM EXAMINATION: WEIGHTAGE – 50%

End Term Examination shall be Three Hours duration and shall be a combination of Short and Long theory/numerical Questions.

H8. GRADING:

The overall marks obtained at the end of the semester comprising all the above three mentioned shall be converted to a grade.

Catalog Description

Robotics and Intelligent Systems, course provides with a working knowledge of methods for design and analysis of robotic and intelligent systems. Particular attention is given to modeling dynamic systems, measuring and controlling their behavior, and making decisions about future courses of action. The content is necessarily broad, and the course level is introductory. The intent is to motivate and prepare students to conduct research projects and for further study through advanced courses in related areas.

G. DETAILED SESSION PLAN

Session	TOPICS	Course Outcomes Addressed	Required Learning Resources (including media)	Pedagogy/ Discussion(s)/ Postings	Assessment
	Module 1: System Modeling				
1	Introduction to System Modeling	**CO1**	**Standard IBM Course Material and materials provided by faculties**	**Lecture**	
2	Biological and cognitive paradigms for robot design	**CO1**		**Lecture**	
3	Declarative-Procedural-Reflexive hierarchy for decision making and control, Articulated robots	**CO1**		**Lecture**	
4	Joint-Link (Denavit-Hartenberg) transformations	**CO1**		**Lecture**	
5	Mobile ground robots, Uninhabited ground robots	**CO1**		**Lecture**	

6	Intelligent agents , Open-loop and closed-loop systems	**CO1**		**Lecture**	
	Module 2 :Artificial intelligence for robotics engineering				
7	Introduction to AI, AI problems and techniques, State space search, types of state space, notation, representation and problems	**CO1**	**Standard IBM Course Material and materials provided by faculties**	**Readings/ brief video/ presentations**	
8	Pegs and disk problem, 8-Queens problem, 8 puzzle problem, Production systems, Search Algorithm	**CO1**		**Lecture**	**Assignment 1**
9	Uninformed search algorithm: BFS, DFS	**CO1**		**Lecture**	
10	Heuristic search techniques: Hill climbing, best first search	**CO1**		**Lecture**	
12	Knowledge Representation: language, framework, Schemes, Planning	**CO1**		**Lecture**	
	Module 3 : Components of an Intelligent Robotic System				
13	Introduction to robotics: Types, classification and components of robot	**CO2**		**Lecture**	

14	Merit and demerit based on geometry, manipulation arms, wrists, robot kinematics	**CO2**		**Lecture**	
15	Homogeneous transformation modelling convention, forward kinematics	**CO2**		**Lecture**	**Test 1**
16	Inverse kinematics, Algebraic solution approach	**CO2**		**Lecture**	
17	Advanced robotics, machine intelligence: Architecture, controllers and application	**CO2**		**Lecture**	
18	Machine Learning, Adv. Control system for robotics arm, Intelligent gripping systems	**CO2**		**Lecture**	
19	Overview of Salford theory, fingerprint sensor, introduction to mobile robots, Common Sensors: CCD, CMOS cameras, Sonar sensors, optoelectronic sensors, Machine Vision system	**CO2**		**Lecture**	
20	Phases of machine vision system, Tool condition monitoring systems(TCMS), NN for TCMS, Architecture of NN, Single layer, Multiple	**CO2**		**Lecture**	

	layer, recurrent, mesh, gradient descent and delta rule,				
	Module 4 : Robot Operating System				
21	Introduction to Robot Operating System (ROS)	**CO3**	**Standard IBM Course Material and materials provided by faculties**	**Lecture**	
22	Application of ROS	**CO3**		**Lecture**	**Assignment II**
	Module 5 : Navigation, SLAM and Speech Recognition and Synthesis				
23	Introduction to SLAM and Speech Recognition and Synthesis	**CO3**		**Lecture**	
24	Computer Vision	**CO3**		**Lecture**	

H. SUGGESTED READINGS:

Text Book: Algorithms for Intelligent Systems and Robotics (IBM ICE Publications)

Reference Book:

- J. Craig, Introduction to Robotics Mechanics and Control, Pearson, 2018.
- B. Ripley, Pattern Recognition and Neural Networks, Cambridge University Press, 1996.

VIDEO RESOURCES: NPTEL Lectures

GUIDELINES

***Cell Phones and other Electronic Communication Devices*:** Cell phones and other electronic communication devices (such as Blackberries/Laptops) are not permitted in classes during Tests or the Mid/Final Examination. Such devices MUST be turned off in the class room.

E-Mail and online learning tool: Each student in the class should have an e-mail id and a pass word to access the LMS system regularly. Regularly, important information – Date of conducting class tests, guest lectures, via online learning tool. The best way to arrange meetings with us or ask specific questions is by email and prior appointment. All the assignments preferably should be uploaded on online learning tool. Various research papers/reference material will be mailed/uploaded on online learning platform time to time.

Attendance: Students are required to have **minimum attendance of 75%** in each subject. Students with less than said percentage shall **NOT** be allowed to appear in the end semester examination.

Course outcome assessment: To assess the fulfilment of course outcomes two different approaches have been decided. Degree of fulfillment of course outcomes will be assessed in different ways through direct assessment and indirect assessment. In Direct Assessment, it is measured through quizzes, tests, assignment, Mid-term and/or End-term examinations. It is suggested that each examination is designed in such a way that it can address one or two outcomes (depending upon the course completion). Indirect assessment is done through the student survey which needs to be designed by the faculty (sample format is given below) and it shall be conducted towards the end of course completion. The evaluation of the achievement of the Course Outcomes shall be done by analyzing the inputs received through Direct and Indirect Assessments and then corrective actions suggested for further improvement.

Passing criterion: Student has to secure minimum 35% marks of the highest marks in that subject individually in both the 'End-Semester examination' and 'Total Marks' in order to pass in that paper.

- Passing Criterion for B. Tech: Minimum 35% Passing of the highest marks

Sample format for Indirect Assessment of Course outcomes

NAME:
ENROLLMENT NO:
SAP ID:
COURSE:
PROGRAM:

Please rate the following aspects of course outcomes of Algorithm for Intelligent Systems and Robotics. Use the scale 1-4*

Sl. No.		1	2	3	4
1	CO1. To discuss the basic concepts of algorithms for intelligent systems and robotics.				
2	CO2. To use of different types of sensors, tactile, proximity, range etc.				
3	CO3. To discuss basic understanding of intelligent machines supported by kinematics and mechanics.				

* 1 Below Average 3 Good

2 Average 4 Very Good