BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
WORK INTEGRATED LEARNING PROGRAMMES
Digital Learning

Part A: Content Design

Course Title	**Artificial Intelligence**
Course No(s)	**IS ZC444 / SS ZC444/SE ZC444**
Credit Units	**3**
Course Authors	**Vimal SP, Raja vadhana P**
Version No	**1.0**
Date	**July 09, 2019**

Course Objectives

No	Course Objective
CO1	To provide solid foundation for designing intelligent agents
CO2	Learn the representation and use of knowledge in inference-based problem solving approaches
CO3	Learn to apply probability theory to describe and model agents operating in uncertain environments
CO4	Learn the optimization models of computation and processing in real world application of intelligent agents

Text Book(s)

T1	Stuart Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", Pearson Education, Third Edition.
T2	Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill Publishing Company, New Delhi, 2003

Reference Book(s) & other resources

R1	Ryszard S. Michalski, Jaime G. Carbonell and Tom M. Mitchell, "Machine Learning: An Artificial Intelligence Approach", Elsevier, 2014
R2	Dan W Patterson, "Introduction to AI and Expert Systems", Prentice Hall of India, New Delhi, 2010
R3	A.M. Turing(1950) Computing Machinery and Intelligence Mind LIX (236): 433-460
R4	Michael Skirpan, Micha Gorelick, The Authority of Fair in Machine Learning https://arxiv.org/pdf/1706.09976.pdf
R5	Christoph Molnar, Interpretable Machine Learning, https://christophm.github.io/interpretable-ml-book/

Modular Content Structure

No	Title of the Module	References
M1	Introduction to AI 1.1. History 1.2. Intelligent Agent & Environment 1.3. Role of Learning 1.4. Expert Systems 1.4.1. Stages of Development 1.4.2. Structure of Knowledge base	T1: Chapter 1, 2, 18.1 R1: Chapter 2 R2 : Chapter 1
M2	Problem Solving: Knowledge representation and Inference 2.1 Search Strategies 2.1.2 Informed Uninformed 1.1. Representation 1.1.1. Logic 1.1.2. Rule system & Fuzzy system 1.1.3. Semantic Nets 1.1.4. Objects 1.3 Planning	T1: Chapter 3, 7, 9.1, 9.2, 14.7 T2: Chapter 6.1, 6.2, 11, 3.5
M3	Reasoning: Static and Dynamic 1.1. Monotonic 1.1.1. Forward Chaining 1.1.2. Backward Chaining 1.2. Non-Monotonic 1.2.1. Probability 1.2.2. Bayesian Networks 1.3 Introduction to Hidden Morkov Model	T1: Chapter 9.2- 9.5, 13, 14.1 -14.4
M4	Introduction to Learning 1.1. Supervised - Induction 1.2. Unsupervised 1.3. Reinforcement Learning 1.4. Neural Network 1.5. Deep Learning	T1: Chapter 18.2, 18.3, 18.7, 21.1-21.3, 21.6 T2 : Chapter 17.4 -17.7, 18.2-18.4 http://www.deeplearningbook.org/contents/intro.html Page 1-8
M5	Optimization Models 1.1. Hill climbing Algorithm 1.2. Genetic Algorithm 1.3. Ant Colony Optimization 1.4. Particle Swarm Optimization	T1: Chapter 4.1 http://www.globalspec.com/reference/66198/203279/chapter-11-introduction-to-particle-swarm-optimization-and-ant-colony-optimization
M6	AI Application 1 : Gaming 1.1. AI & Gaming 1.2. Dynamic Programming & Backtracking 1.3. Min-Max Algorithm 1.4. Alpha – beta Pruning	T1 : Chapter 5 T2: Chapter 12
M7	AI Application 2 : Natural Language Processing 1.1. Process 1.2. Syntax & Semantics 1.3. Disambiguation & Information retrieval	T2: Chapter 15 T1: Chapter 22 , 23
M8	Anatomy of building AI systems 1.1. Shortcomings of AI 1.2. Building Fair models 1.3. Interpretable models	T1: Chapter 25 R4, R5 Chapter 6

Learning Outcomes:

No	Learning Outcomes
LO1	Understand the environment and process of development to build intelligent agents
LO2	Identify heuristics to pursue goals in exponentially large search spaces.
LO3	Represent problem and derive reasoning using logical inferences
LO4	Apply probability theory to describe and model agents operating in uncertain environments
LO5	Analyse ways to supervise agents to learn and improve their behaviour.

Part B: Course Handout

Academic Term	Second Semester 2020-2021
Course Title	Artificial Intelligence
Course No	IS ZC444 / SS ZC444/SE ZC444
Lead Instructor	Saikishor Jangiti

Glossary of Terms

1. Contact Hour (CH) stands for a hour long live session with students conducted either in a physical classroom or enabled through technology. In this model of instruction, instructor led sessions will be for 22 CH.
    a. Pre CH = Self Learning done prior to a given contact hour
    b. During CH = Content to be discussed during the contact hour by the course instructor
    c. Post CH = Self Learning done post the contact hour
2. Contact Hour (CS) stands for a two-hour long live session with students conducted either in a physical classroom or enabled through technology. In this model of instruction, instructor led sessions will be for 11 CS.
    a. Pre CS = Self Learning done prior to a given contact session
    b. During CS = Content to be discussed during the contact session by the course instructor
    c. Post CS = Self Learning done post the contact session
3. RL stands for Recorded Lecture or Recorded Lesson. It is presented to the student through an online portal. A given RL unfolds as a sequences of video segments interleaved with exercises
4. SS stands for Self-Study to be done as a study of relevant sections from textbooks and reference books. It could also include study of external resources.
5. LE stands for Lab Exercises
6. HW stands for Home Work.
7. M stands for module. Module is a standalone quantum of designed content. A typical course is delivered using a string of modules. M2 means module 2.

Teaching Methodology (Flipped Learning Model)

The pedagogy for this course is centered around flipped learning model in which the traditional class-room instruction is replaced with recorded lectures to be watched at home as per the student's convenience and the erstwhile home-working or tutorials become the focus of classroom contact sessions. Students are expected to finish the home works on time.

Contact Session Plan

- Each Module (M#) covers an independent topic and module may encompass more than one Recorded Lecture (RL) or Lecture Segment (LS).
- Contact Sessions **(2hrs each week)** are scheduled alternate weeks after the student watches all Recorded Lectures (RLs) of the specified Modules (listed below) during the previous week
- In the flipped learning model, Contact Sessions are meant for in-classroom discussions on cases, tutorials/exercises or responding to student's questions/clarification--- may encompass more than one Module/RLs/CS topic.
- Contact Session topics listed in course structure (numbered CSx.y) may cover several RLs; and as per the pace of instructor/students' learning, the instructor may take up more than one CS topic during each of the below sessions.

Detailed Structure

- Each of the sub-modules of **Recorded Lectures** (indicated by RLx.y / LS x.y / LSx.yVz) shall delivered via **30 – 60mins videos** followed by:
- **Contact session** (CSx.y) of 2Hr each for illustrating the concepts discussed in the videos with exercises, tutorials and discussion on case-problems (wherever appropriate); contact sessions (CS) may cover more than one recorded-lecture (RL) videos.

Course Contents

Time	Type	Description	References
M1: Introduction to AI			
Pre-CS	RL 1.1	RL 1.1.1. Course Introduction RL 1.1.2. Introduction to AI RL 1.1.3. Definition & History RL 1.1.4. Intelligent Agent & Environment	
	RL 1.2	RL 1.2.1. Role of Learning & Expert System	
During CS	CS 1.1	CS 1.1.1. Review of concepts covered in the Recorded lecture CS 1.1.2. Discuss use case for designing expert system CS 1.1.3. Problem on identifying the PEAS description given a problem statement and the nature of task environment	
Post-CS	LE 1.1		
	SS 1.1		
	HW 1.1	Identify & describe the PEAS of the task environment	T1: Exercise 2.4
	QZ 1.1		

Lab Reference			
M2: Problem Solving: Knowledge representation and Inference			
Pre-CS	RL 2.1	Search Strategies : Informed & Uninformed	
	RL 2.2	RL 2.2.1. Logic: Predicate & Propositional Logic RL 2.2.2. Rule & Fuzzy System RL 2.2.3. Semantic Nets RL 2.2.4. Classes , Objects & Events	
During CS	CS 2.1	CS 2.1.1. Review of concepts covered in Recorded Lecture. CS 2.1.2. A* algorithm efficiency. Problem in searching techniques CS 2.1.3. AO* Algorithm – AND-OR Graphs	
	CS 2.2	CS 2.2.1. Solve one problem in each predicate & propositional logic CS 2.2.2. Encoding Query into Semantic net representation and Convert into frames	
	CS 2.3	CS 2.3.1. Planning – Goal stack ,Non-linear & Hierarchical planning CS 2.3.2. Constraint Satisfaction Problem	T2: Chapter 13
Post-CS	LE 2.1	Implement Informed and Uniformed Search	Lab.No.1
	SS 2.1	Planning	T2: Chapter 13
	HW 2.1	Understand the syntax-Semantics of predicate logic & Logic Resolution	T1: Exercises 8.9, 8.24, 9.23
	QZ 2.1		
Lab Reference			
M3: Reasoning: Static and Dynamic			
Pre-CS	RL 3.1	Monotonic Reasoning : Forward & Backward Chaining	
	RL 3.2	RL 3.2.1. Non-monotonic - Probabilistic Reasoning & Bayesian Networks RL 3.2.2. Introduction to HMM	
During CS	CS 3.1	CS 3.1.1. Review of concepts covered in the Recorded lectures CS 3.1.2. Solve Problem by inference using forward chaining, backward chaining CS 3.1.3. Solve problem in Bayesian network & Dempster Shafer theory	T2: Chapter 8.3, 8.4
Post-CS	LE 3.1	Simulate the working of inference in a rule based system	Lab.No.2
	SS 3.1	Implement logical reasoning for Wumpus world problem	Chapter 13.6
	HW 3.1	Formulation of Bayesian Networks alone can be worked out in the exercise problem. HMM is not	T1: Exercise 15.13

		required.	
	QZ 3.1	Quiz. Revise the concepts learnt in Module 1,2,3	
Lab Reference			
M4: Introduction to Learning			
Pre-CS	RL 4.1	RL 4.1.1. Supervised - Induction by decision trees, Unsupervised Learning, Reinforcement Learning RL 4.1.2. Neural Network RL 4.1.3. Deep Learning – CNN , RNN	
During CS	CS 4.1	CS 4.1.1. Revise the concepts covered in the Recorded Lectures CS 4.1.2. Build a model using reinforcement learning for given data	T1: Chapter 21
	CS 4.2	CS 4.2.1. Candidate Elimination algorithm CS 4.2.2. Neural Net , Backward & Forward Propagation algorithm	
Post-CS	LE 4.1	Familiarize with the working of Learning algorithms	Lab.No.3
	SS 4.1		
	HW 4.1	Identify features for a problem to implement reinforcement learning	T1 : Exercise – 21.6
	QZ 4.1		
Lab Reference			
M5: Optimization Models			
Pre-CS	RL 5.1	RL 5.1.1. Hill Climbing, Simulated Annealing, Local Beam search, Genetic Algorithm RL 5.1.2. Particle Swarm, Ant Colony	
During CS	CS 5.1	CS 5.1.1. Review the concepts covered in the Recorded Lectures CS 5.1.2. Discuss the Travelling salesman problem solution w.r.t to each of the optimization model	
Post-CS	LE 5.1	Understand the implementation of Optimizations in Problem Solving	Lab.No.4
	SS 5.1	Metaheuristic Optimization Algorithms	T1: Chapter 4
	HW 5.1		
	QZ 5.1		
Lab Reference			
M6: AI Application 1 : Gaming			
Pre-CS	RL 6.1	RL 6.1.1. Min-Max Algorithm RL 6.1.2. Alpha – Beta Pruning RL 6.1.3. Backtracking , Gaming as Constraint Satisfaction Problem	
During CS	CS 6.1	CS 6.1.1. Review of concepts covered in the Recorded lectures	

		CS 6.1.2. Problem solving in Min-Max Alpha-Beta pruning CS 6.1.3. CSP in Gaming	
Post-CS	LE 6.1	Understand the design of Gaming	Lab.No.5
	SS 6.1	Games in partially observable environment	T1: Chapter 5.5-5.8
	HW 6.1	Game tree construction & Interpretation	T1: Exercise 5.8
	QZ 6.1		
Lab Reference			
M7: AI Application 2 : Natural Language Processing			
Pre-CS	RL 7.1	RL 7.1.1. NLP Process, Syntax, Semantics RL 7.1.2. Disambiguation & Information retrieval	
During CS	CS 7.1	CS 7.1.1. Review of concepts covered in the Recorded lectures CS 7.1.2. Construction of simple grammar. Construct parse trees and find the probabilities given grammar & Sentence	
Post-CS	LE 7.1	Familiarize with the basics of natural language processing	Lab No.6
	SS 7.1		
	HW 7.1	Understand the parsing process of NLP given a query.	T1: Exercise 23.10
	QZ 7.1	Quiz. Revise the concepts learnt in Module 4,5,6 & 7	
Lab Reference			
M8: Anatomy of building AI systems			
Pre-CS	RL 8.1	RL 8.1.1. Shortcomings of AI , Building Fair Model, Interpretable Model	
During CS	CS 8.1	CS 8.1.1. Review of Concepts covered in the Recorded lecture. CS 8.1.2. Discuss sample case study/ example.	https://jolt.law.harvard.edu/digest/a-legal-anatomy-of-ai-generated-art-part-i
Post-CS	LE 8.1	Apply right technique to build AI system	Lab No.7
	SS 8.1		
	HW 8.1		
	QZ 8.1		
Lab Reference			

* Refer Appendix for detailed course plan

Detailed Plan for Lab work/Design work

Lab No	Lab Objective	Lab Sheet/Capsule Access URL	Content Reference
1	Implement Informed and Uniformed Search	TBU	Module 2.1 - Search Strategies
2	Simulate the working of inference in a rule based system	TBU	Module 2.2, 3.1: Unification & Resolution
3	Familiarize with the working of Learning algorithms	TBU	Module 4.1, 4.3 Decision Trees & Reinforcement Learning
4	Understand the implementation of Optimizations in Problem Solving	TBU	Module 5.2 : Genetic Algorithm
5	Understand the design of Gaming	TBU	Module 6.3 Min-Max Algorithm
6	Familiarize with the basics of natural language processing	TBU	Module 7
7	Apply right technique to build AI system	TBU	Module 8

Select Topics and Case Studies from business for experiential learning

<Tailored to instructor's delivery in discussion with the lead faculty of the programme>

Topics No.	Select Topics/Case Studies in Syllabus for experiential learning	Access URL

Evaluation Scheme:

Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

No	Name	Type	Duration	Weight	Day, Date, Session, Time
EC-1	Quiz-I	Online	-	5%	February 1-15, 2021
	Quiz-II	Online	-	5%	March 1-15, 2021
	Assignment / Lab	Offline	-	10%	April 1-15, 2021
EC-2	Mid-Semester Test	Closed Book	1.5 hours	30%	Friday, 05/03/2021 (AN) 2 PM – 4 PM
EC-3	Comprehensive Exam	Open Book	2.5 hours	50%	Friday, 30/04/2021 (AN) 2 PM – 5 PM

Important Information:

Syllabus for Mid-Semester Test (Closed Book): Topics in CS 1-5.
Syllabus for Comprehensive Exam (Open Book): All topics given in plan of study

Evaluation Guidelines:

1. For Closed Book tests: No books or reference material of any kind will be permitted. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
2. For Open Book exams: Use of prescribed and reference text books, in original (not photocopies) is permitted. Class notes/slides as reference material in filed or bound form is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
3. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam. The genuineness of the reason for absence in the Regular Exam shall be assessed prior to giving permission to appear for the Make-up Exam. Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self-study schedule as given in the course handout, attend the lectures, and take all the prescribed evaluation components such as Assignment/Quiz, Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.

Appendix

Contact Session & Self Study Plan

Contact hour	Pre-contact hour prep	During Contact hour	Post-contact hour
1	RL 1.1	CS 1.1	
2	RL 1.2		HW1.1
3	RL2.1	CS 2.1.1, CS 2.1.2	
4		CS 2.1.3	LE 2.1
5	RL 2.2	CS 2.2.1	
6		CS 2.2.2	HW 2.1
7	SS 2.1	CS 2.3.1	
8		CS 2.3.2	
9	RL 3.1	CS 3.1.1, CS 3.1.2.	
10	RL 3.2	CS 3.1.3.	LE 3.1, SS 3.1, HW 3.1

11	**Review / Lab Sessions / Buffer**		
12			
13	RL 4.1.1	CS 4.1.1, CS 4.1.2	
14		CS 4.1.2.	LE 4.1, HW 4.1
15	RL 4.1.2, RL 4.1.3	CS 4.2.1	
16		CS 4.2.2	
17	RL 5.1.1	CS 5.1.1, CS 5.1.2	
18	RL 5.1.2	CS 5.1.2	LE 5.1, SS 5.1
19	RL 6.1.1, RL 6.1.2	CS 6.1.1, CS 6.1.2	
20	RL 6.1.3	CS 6.1.2, CS 6.1.3	LE 6.1, SS 6.1, HW 6.1
21	RL 7.1	CS 7.1	LE 7.1, HW 7.1
22	RL 8.1	CS 8.1	LE 8.1
23	**Review / Lab Session / Buffer**		
24			