ARTIFICIAL INTELLIGENCE IN RADIO COMMUNICATION
(ECEN 3221)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Limited dynamic range in digital RF system can be improved by which of the following?
(a) Digital filter (b) Digital amplifier
(c) Digital equalizer (d) Digital suppressor.

(ii) Which of the following parameters define software defined radio applications?
(a) Linearity, SNR (b) Dynamic range, SNR
(c) Linearity, Dynamic range (d) Bandwidth, SNR.

(iii) The sampling rate of promising SDR technology ranges between which of the following?
(a) 1 MHz-100 MHz (b) 10 MHz – 100 MHz
(c) 1MHz – 1GHz (d) 1MHz -10 GHz.

(iv) The action of the simple reflex agent completely depends upon which of the following?
(a) Perception history (b) Current perception
(c) Learning theory (d) Utility functions.

(v) How does an artificial intelligence agent interact with its environment?
(a) Using sensors and actuators (b) Using only sensors
(c) Using only actuators (d) None of (a), (b) & (c).

(vi) Which among the following is a component of AI?
(a) Training (b) Designing (c) Learning (d) Puzzling.

(vii) The measure of performance of an AI agent is measured using which of the following?
(a) Learning agent (b) Changing agent
(c) Both (a) and (b) (d) None of (a), (b) & (c).

(viii) Which of the following are appropriate levels for a knowledge-based AI agent?
(a) Knowledge level (b) Logical level
(c) Implementation level (d) All of (a), (b) & (c).

(ix) Which of the following is the function of an AI agent?
(a) To map the percept sequence to an action
(b) To map the goal sequence to an action
(c) To work without direct interference from any external factor like human
(d) To map the environment sequence to an action.

(x) In case a machine is capable of changing its course of action based on the external environment without any external help, then the machine is called as?
(a) Intelligent (b) Mobile
(c) Both (a) and (b) (d) None of (a), (b) & (c).

Group- B

2. (a) Recall the meaning of the word "Cognitive" and define the phrases "Cognitive Engine" and "Policy Engine"? [(CO1,CO2)(Remember/LOCQ)]
(b) With the help of proper diagram, construct the simplified block diagram of software defined radio receiver and also mention the components of SDR? [(CO2)(Evaluate/HOCQ)]
(c) What are the responsibilities of user interface of the cognitive engine? [(CO1)(Understand/LOCQ)]
4 + (4 + 2) + 2 = 12

3. (a) Sketch the model of generic cognitive radio architecture with proper explanation. [(CO3)(Apply/IOCQ)]
(b) Explain the applications of artificial intelligence in wireless communications. [(CO2,CO3)(Understand/LOCQ)]
(c) Describe with proper example about fully observable and partially observable environment. [(CO1,CO3)(Evaluate/HOCQ)]
4 + 4 + (2 + 2) = 12

Group - C

4. (a) Define objective space in optimization problems. [(CO3)(Remember/LOCQ)]
(b) Explain how objective space describes the radio resources that determine the radio behaviour? [(CO3)(Evaluate/HOCQ)]
(c) Compare between simple reflex agent and model based reflex agent. [(CO1,CO3)(Analyze/IOCQ)]
2 + 5 + 5 = 12

5. (a) Discuss the Five spectrum sharing steps in SDR. [(CO2)(Understand/LOCQ)]

(b) Describe and draw the dependency map of objective functions in optimization of radio resources. [(CO3,CO4)(Create/HOCQ)]

(c) List the dependencies of BER on signal-noise ratio. [(CO3)(Remember/LOCQ)]

5 + 5 + 2 = 12

Group - D

6. (a) Illustrate how the cognitive engine can use the objectives to analyse the behaviour of different waveforms and select the best one? [(CO3,CO4)(Analyze/IOCQ)]

(b) Discuss in details about the uses and advantages of genetic algorithm. [(CO5)(Understand/LOCQ)]

(c) Define spectrum underlay. [(CO4)(Remember/LOCQ)]

5 + 5 + 2 = 12

7. (a) Discuss about the population adaptation and variable adaptation technique. [(CO5)(Understand/LOCQ)]

(b) Construct a general algorithm-based optimization flowchart and explain it in brief. [(CO5)(Evaluate/HOCQ)]

5 + 7 = 12

Group - E

8. (a) Explain the features of distributed artificial intelligence. [(CO6)(Analyze/IOCQ)]

(b) With the help of proper diagram, discuss the concept of cognitive engine architecture with CBDT. [(CO6)(Evaluate/HOCQ)]

(c) Define the term temporal forgetfulness. [(CO6)(Remember/LOCQ)]

4 + 5 + 3 = 12

9. (a) Illustrate in details about the types of distributed artificial intelligence approaches. [(CO6) (Analyze/IOCQ)]

(b) Discuss the application areas where distributed artificial intelligence has been applied. [(CO6) (Understand/LOCQ)]

(c) Define the concept of in-band signalling in cognitive radio. [(CO6) (Remember/LOCQ)]

4 + 5 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	43.75	22.92	33.33

Course Outcome (CO):

After the completion of the course students will be able to

1. Understand difference between passive radios and cognitive radios.
2. Explain difference between SDR and cognitive Radios
3. Apply in AI in radios.
4. Analyze weakness on cognitive radios
5. Develop radios based on Genetic Algorithm (GA).
6. Evaluate radio performance.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.