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

(ii) The measure of performance of an AI agent is measured using?
(a) Learning agent (b) Changing agent
(c) Both (a) and (b) (d) None of these.

(iii) Flat fading channel is also known as which of the following?
(a) Amplitude varying channel (b) Wideband channel
(c) Phase varying channel (d) Frequency varying channel.

(iv) A technique that was developed to determine whether a machine could or could not demonstrate the artificial intelligence known as the?
(a) Boolean Algebra (b) Turing Test
(c) Logarithm (d) Algorithm.

(v) Which AI technique enables the computers to understand the associations and relationships between objects and events?
(a) Heuristic Processing (b) Cognitive Science
(c) Relative Symbolism (d) Pattern Matching.

(vi) Which of the following is not an advanced requirement in terms of Software Defined Radio?
(a) Adaptive networks (b) Adaptive diversity
(c) Multiband (d) Innovation signalling.

(vii) Which of the following are the ways to achieve AI in real-life?
(a) Machine Learning (b) Deep Learning
(c) Both (a) & (b) (d) None of the above.

(viii) Which of the following allow several transmitters to transmit in the same place on the same frequency with very little interference?
(a) Ultra wide band techniques
(b) Spread spectrum
(c) Spread spectrum and ultra wide band techniques
(d) None of the above.

(ix) Which of the following is a radio communication system where components that have been traditionally implemented in hardware are instead implemented by means of software on a personal computer or embedded system?
(a) Software Architecture (b) Hardware Architecture
(c) Software-defined radio (d) None of the above.

(x) The modem may include which of the following to correct channel multipath artefacts?
(a) Equalizer (b) Frequency offset
(c) AGC (d) Interference suppressor.

Group- B

2. (a) Explain the importance of artificial intelligence? Recall the benefits of using SDR? [(CO1,CO2)(Understand, Remember/LOCQ)]
(b) Based on the capabilities of AI, describe the different classification of AI? [(CO3)(Evaluation/HOCQ)]
(c) Recall the meaning of the word "Cognitive" and define the phrases "Cognitive Engine" and "Policy Engine"? [(CO1,CO2)(Remember/LOCQ)]
(2 + 2) + 4 + 4 = 12

3. (a) Illustrate in details about simple GNU radio flow graph with proper block diagram? [(CO3)(Analysis/IOCQ)]
(b) Tell in details about which assessment is used to test the intelligence of the machine? [(CO3)(Evaluate/HOCQ)]
(c) Evaluate how Artificial Intelligence techniques are applied in Cognitive Radio? [(CO1,CO2,CO3)(Create/HOCQ)]
4 + 4 + 4 = 12

Group – C

4. (a) Tell the objectives that are served by cognitive engine design? Summarize the basic three components required by cognitive radio actions? [(CO1,CO2,CO4)(Evaluate, Create/HOCQ)]
(b) With the help of proper example, illustrate the comparison between deterministic environment and stochastic environment? [(CO3)(Apply, Analyze/IOCQ)]
(c) Explain in details about SDR receiver with proper example? [(CO1,CO2)(Analyze/IOCQ)]
(2 + 2) + 4 + 4 = 12

5. (a) Describe the actions of Mitola's loop in cognitive engine with proper diagram? [(CO3,CO4)(Understand/LOCQ)]
   (b) Explain with proper diagram and justify one application of Goal based agents? [(CO3)(Evaluate/HOCQ)]
   (c) Illustrate in details about the 5 spectrum sharing steps in SDR? [(CO1,CO2)(Apply/IOCQ)]

3 + 4 + 5 = 12

Group - D

6. (a) State the difference between exploitation and exploration with respect to search capabilities? Describe the files which provide the mechanism for genetic representation of radio platform capabilities? [(CO4)(Remember/LOCQ)]
   (b) Explain the three main types of opportunistic employment of the primary spectrum which are possible in cognitive radio? [(CO4)(Understand/LOCQ)]
   (c) Summarize in details about the challenges which are yet open and current under debate in the framework of research on CRS? [(CO4)(Evaluate/HOCQ)]

(3 + 2) + 3 + 4 = 12

7. (a) Evaluate in details about the spectrum sensing limitations in cognitive radio networks? [(CO4)(Create/HOCQ)]
   (b) Discuss in details about the cognitive mesh networks? [(CO4)(Understand/LOCQ)]
   (c) Illustrate any one example of roulette wheel selection in a GA? [(CO5)(Analyze/IOCQ)]

4 + 4 + 4 = 12

Group - E

8. (a) Illustrate in details about WSGA? [(CO6)(Analyze/IOCQ)]
   (b) Describe the general workflow of a simple genetic algorithm? [(CO5)(Understand/LOCQ)]
   (c) Explain the flow graphs for profiling GNU radio modulators and demodulators? [(CO6)(Evaluate/HOCQ)]

4 + 5 + 3 = 12

9. (a) Explain in details about any one objective function in multi-objective optimization? [(CO6)(Analyze/IOCQ)]
   (b) Illustrate in details about the case based decision theory? [(CO6)(Analyze/IOCQ)]
   (c) Describe the foundations of the genetic algorithms? [(CO5)(Understand/LOCQ)]

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	43	25	32

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