

Part B – Expert Systems

Attempt ALL questions in this part.

24. Large organisations use a range of information systems including *deductive databases*, *decision support systems* and *expert systems*.

- (a) Distinguish between a ‘decision support system’ and an ‘expert system’. 2
- (b) PROSPECTOR is an expert system that was developed as an aid for geologists. Describe the PROSPECTOR expert system in terms of its category, domain and main characteristics. 3
- (c) Which characteristics does a deductive database share with an expert system? 1

25. Inverclyde College offers a wide range of courses for full-time and part-time students. Each course consists of 3 units and some units are common to a number of different courses. This means that students from different courses often attend the same lecture. Every year the college timetabler has the job of creating individual timetables for lecturing staff and students. The college would like to develop an expert system that would help the timetabler to prepare individual timetables for the start of each session.

- (a) Describe **two** limitations of using an expert system for the task described. 2
- (b) If the development of the expert system is to be successful, the college timetabler must be consulted at various stages in the development of the expert system.
- (i) Describe the role of the college timetabler during the knowledge acquisition stage of development. 1
- (ii) Describe the role of the college timetabler during the validation of the expert system. 1
- (c) The college would like to enable students to check their individual timetables via the college web site.
- Describe **two** security issues that must be considered if the college is to allow students to access timetable information via the college web site. 2

[Turn over

26. All successful gardeners understand the importance of planting the correct type of plant for the soil in their gardens. The expert system below uses forward chaining rules and contains information about soil conditions.

IF soil is free draining AND
retains moisture
THEN soil is loamy (0.9).

IF soil is free draining AND
retains moisture AND
soil feels soapy
THEN soil is silty (0.7).

IF soil is free draining AND
soil feels gritty
THEN soil is sandy (0.6).

IF soil is free draining AND
soil feels stony
soil is NOT acidic
THEN soil is chalky (0.7).

IF soil is NOT free draining AND
soil is acidic
THEN soil is peaty (0.6).

Matt Evans is a keen gardener. He uses the expert system above to determine the type of soil in his garden. He provides the expert system with the following facts and certainty factors.

soil is free draining	CF 0.6
soil retains moisture	CF 0.5
soil feels soapy	CF 0.7

- (a) Calculate the certainty factor of the conclusion that the soil is loamy. Show your working. **2**
- (b) What conclusion will be drawn by the expert system based on the facts provided? You must explain your answer. **3**
- (c) (i) Explain the use made of the *RETE algorithm* in a forward chaining expert system. **2**
- (ii) Explain the need for *conflict resolution* in a forward chaining expert system. **2**
- (iii) Describe how the *refractoriness* strategy for conflict resolution works. **2**

[Turn over

SECTION III - Part B – Expert Systems (Continued)

Marks

27. ROCKET is an electrical store that sells electrical products in stores throughout Scotland. Customers who purchase products from ROCKET are asked if they wish to purchase an extended service warranty. For the duration of its extended warranty, customers who have any problems with an electrical product purchased from ROCKET can call out a service engineer. The service engineer will then arrange a suitable date and time to call at the customer's home to repair the product.

The IT department at ROCKET is developing a fault diagnosis expert system for use by the service engineers. The expert system will run on laptop computers that the service engineers can take to a customer's house when on a service call. The service engineer will be able to use the expert system to help identify the source of any fault. The expert system will also be able to provide guidance about any repairs that are needed.

- (a) Identify **two** benefits of developing an expert system for this purpose. 2

- (b) Several of the service engineers who work for ROCKET are concerned about what happens if the expert system misdiagnoses a fault in an electrical product and they then follow any inaccurate guidance that is subsequently provided by the expert system.

Who is responsible for any bad advice that is provided by an expert system? Justify your answer. 2

- (c) As the expert system is being developed, it is possible that errors could occur at each stage of its development. Describe **one** source of an error that could occur during **each** of the following stages of development:

(i) Knowledge acquisition

(ii) Knowledge representation 2

- (d) Compare an expert system with a relational database management system in terms of –
• Representation of data/knowledge
• Extraction of data/knowledge

Use your comparison to justify why the IT Manager at ROCKET decided to develop an expert system rather than develop a relational database system for the electrical product fault diagnosis system. 4

SECTION III - Part B – Expert Systems (Continued)

Marks

28. Clyde Shore Zoo has commissioned a team of developers to create an expert system. It is hoped that the expert system will provide zoo keepers with fast access to specialist advice about the welfare of all animals in the zoo.

(a) The developers of the expert system have used propositional logic to represent the following facts gathered from the keeper who has responsibility for looking after the penguins at the zoo.

Proposition	Fact
P	Penguins eat fish.
Q	Penguins like fish.
R	Penguins are birds.
S	Penguins can fly.

Use propositional logic to represent the following statements –

- (i) Penguins like fish therefore penguins eat fish.
- (ii) Penguins cannot fly.
- (iii) Penguins are birds and penguins like fish.

3

(b) The Clyde Shore Zoo has several different species of penguin, each with their own identifying characteristics. The penguin keeper has provided the following statements about two of the species.

A	Macaroni penguins are very distinctive and easy to recognise. They have a golden yellow crest in the middle of their forehead.
----------	--

B	Chinstrap penguins have a small black band running under their chin. They are fairly easy to identify.
----------	--

Produce *backward* rules that represent the knowledge contained in statements A and B above. Each rule should include an appropriate certainty factor and should identify a species of penguin from its characteristics.

4

[Turn over

SECTION III - Part B – Expert Systems (Continued)

Marks

29. The knowledge base of a backward chaining expert system contains rules that are used to determine the salary of company employees. Part of the knowledge base is shown below.

1	ADVISE Salary is £21750 IF Level of employment is manager AND Employee has professional qualifications AND Department has more than 10 staff.
2	ADVISE Salary is £19500 IF Level of employment is manager AND Employee has professional qualifications AND NOT Department has more than 10 staff.
3	ADVISE Salary is £17000 IF Level of employment is manager AND NOT Employee has professional qualifications.
4	ADVISE Salary is £9500 IF Level of employment is junior.
5	ADVISE Salary is £14750 IF Level of employment is experienced AND Employee has 5 or more years of experience.
6	ADVISE Salary is £12750 IF Level of employment is experienced AND NOT Employee has 5 or more years of experience.

(a) Samantha is an employee of the company. She is not a manager but she has 8 years experience with the company. She uses the expert system to check her salary.

- (i) How many questions does the expert system ask before providing Samantha with the following advice?
Salary is £14,750 1
- (ii) Samantha asks the expert system to justify *how* it arrived at this advice. What justification does the expert system provide? 1
- (iii) Explain how the expert system generates this justification, making reference to the rule tree in your answer. 2

SECTION III - Part B – Expert Systems (Continued)

Marks

29.
cont (b) The first rule in the knowledge base above could be rewritten as a *forward chaining* rule:

IF Level of employment is manager AND Employee has professional qualifications AND Department has more than 10 staff THEN Salary is £21750.
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- (i) Give **one** advantage of using backward chaining systems rather than forward chaining systems. 2
- (ii) Give **one** advantage of using forward chaining systems rather than backward chaining systems. 2
- (c) Represent the knowledge contained in the rules above as a *factor table*. 4

[END OF PART B – EXPERT SYSTEMS]

(50)

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SECTION III

Section III – This section has three parts

PART A – Applied Multimedia

Pages 12-14

PART B – Expert Systems

Pages 15-19

PART C – The Internet

Pages 20-24

Choose **one** part and attempt **all** of the questions in this part.

[Turn over

Part B – Expert Systems

Attempt ALL questions in this part.

24. www.camerasforu.co.uk is Web site that advertises and sells digital cameras and digital video cameras from a number of different manufacturers. The site provides an on-line expert system that provides customers with advice on the camera that best suits their needs. The expert system was developed using an expert system *shell*.
- (a) Describe **two** limitations of the camerasforu expert system described above. 2
- (b) The components of any expert system include a *knowledge base*, *inference engine* and *user interface*.
- (i) Explain the purpose of the inference engine.
- (iii) Explain the use made of a *knowledge representation language* during the development of the camerasforu expert system. 2
25. Research into the use of expert systems in medicine started in the early 1970's and produced a number of 'classical' expert systems, including *INTERNIST*, *MYCIN* and *ONCOCIN*.
- (a) Explain how the INTERNIST and MYCIN expert systems differ from ONCOCIN in terms of their *classification*. 1
- (b) The ONCOCIN expert system was developed to be a clinical *decision support system*. Distinguish between an expert system and a decision support system in terms of their purpose within the field of medicine. 2
- (c) The increased use of expert systems in the field of medicine has brought about many concerns regarding the social, legal and ethical implications associated with their use. For example, many people are concerned about the implications for an experienced doctor who decides to take a particular course of action without consulting an expert system when it is later shown that the expert system may have been able to provide a preferable alternative.
- (i) Describe **one** legal implication that could arise from this situation.
- (ii) Describe **one** ethical implication that could arise from this situation. 2

[Turn over

Part B – Expert Systems (continued)

26. GlasgowDine is an expert system that recommends restaurants in Glasgow based on occasion, atmosphere and food preferences. It uses information provided by the user to decide what restaurant characteristics would be preferred for the event. The expert system uses *forward chaining* rules. Part of the GlasgowDine expert system is shown below.

R1 IF Occasion is family meal
 AND Atmosphere is lively
 AND Food preference is European
 AND Cost is moderate
 THEN Suitable restaurant is CharleyCool.

R2 IF Occasion is family meal
 AND Atmosphere is lively
 AND Food preference is European
 THEN Suitable restaurant is Gr8@Gordos.

R3 IF Occasion is business lunch
 AND Atmosphere is relaxed
 AND Food preference is European
 AND Location is city centre
 THEN Suitable restaurant is Uropa.

R4 IF Occasion is business lunch
 AND Atmosphere is relaxed
 AND Food preference is European
 THEN Suitable restaurant is ChisCo.

R5 IF Occasion is business lunch
 AND Atmosphere is relaxed
 AND Food preference is Asian
 THEN Suitable restaurant is Thai&Collar.

- (a) Maisie Mo is hosting a business lunch for clients in the centre of Glasgow next month. The lunch is to be a relaxed event for clients who enjoy European food. She uses the GlasgowDine expert system to find a suitable restaurant.

Given the facts above, state the rules that would exist in the *conflict set*.

2

- (b) What advice would be given to Maisie Mo by the GlasgowDine expert system if:

(i) a *rule ordering* algorithm was used to resolve the conflict? Justify your answer.

(ii) a *specificity* algorithm was used to resolve the conflict? Justify your answer.

4

Part B – Expert Systems (continued)

27. (continued)

- (c) Evaluate the GlasgowDine expert system in terms of:
- its domain
 - the range and coverage of the rules shown

2

28. REHAB is a rule-based expert system that is being developed for use in social security offices. The expert system will be used to refer recipients of social security disability allowance to employment rehabilitation services.

Due to the pressure of work faced by experienced caseworkers responsible for the assessment and review of recipients, the current situation of many recipients cannot be reviewed for several months. As a result, recipients miss out on the benefits offered by the rehabilitation services.

By developing REHAB, it is hoped that unqualified administration staff will be able to use the expert system to reach unbiased and consistent assessment decisions regarding referral of the recipients of disability allowance to employment rehabilitation services. Eventually, it is hoped that administration staff using the expert system will be able to make assessments in less time and with a level of accuracy superior to the experienced caseworkers using manual methods.

- (a) Identify a suitable *domain expert* for the development of the REHAB expert system and describe their role during system validation.

2

- (b) Errors could occur at any stage of the development of the REHAB expert system.
- (i). Describe an error that could be attributed to inferencing.
 - (ii). Describe one other source of error.

2

- (c) The knowledge engineer must decide whether to represent the domain knowledge as *backward chaining* or *forward chaining* rules.

- (i) Suggest **two** factors would be used to determine the type of inference engine suitable for the REHAB expert system. Justify your answer by explaining the relevance of each factor you suggest.

- (ii) Give one reason why the developers of the REHAB expert system may decide to incorporate both backward and forward chaining.

3

- (d) Compare the *quality of information* provided by the REHAB expert system with the quality of similar information provided by experienced caseworkers in terms of:

- timing
- availability

2

[Turn over

Part B – Expert Systems (continued)

29. An expert system is being developed to identify and classify animals. The following knowledge is to be stored in the knowledge base of the expert system:

A mammal is an animal that has hair and provides milk for its young. A carnivore is a meat-eating mammal with claws and pointed teeth whereas an ungulate is a mammal that chews cud and has hooves. A cheetah is a carnivore with black spots and a tiger is a carnivore with black stripes. A giraffe is an ungulate with a long neck and a zebra is an ungulate with black stripes.

- (a) Derive *attribute pairs* from this information about **all** the animals provided above. The attribute pairs should be in the form:

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ungulate (mammal, chews_cud, has_hooves)
cheetah (carnivore, has_black_spots)
```

5

- (b) The developers of the expert system decide to represent knowledge about birds as *factor tables*. The factor tables are shown below.

Lays eggs	Has feathers	Classification
Yes	Yes	Bird

Bird	Can fly	Can swim	Classification
Yes	Yes	Yes	Duck
Yes	No	No	Ostrich
Yes	No	Yes	Penguin

- (i) Represent the factor tables above as a *decision tree*.
- (ii) Compare the use of factor tables and a decision tree to represent the knowledge about birds.
- (c) Additional knowledge about elephants is to be represented using *first order predicate logic*. Use the information in the table below to represent the following statements in first order predicate logic:

Predicate	Meaning
elephant(X)	X is an elephant
grey(X)	X is grey
has_large_ears(X)	X has large ears

- (i) All elephants are grey.
- (ii) African elephants have large ears.
- (d) The knowledge about animals could have been stored in a relational database system rather than an expert system. Compare the two types of system in terms of the methods used to extract information and knowledge.

6

5

2

Part B – Expert Systems (continued)

30. SPOT-OUT is an expert system that provides users with advice about stain removal. SPOT-OUT is a rule based expert system that makes use of *certainty factors*.

(a) Give **two** uses made of certainty factors in an expert system.

2

(b) The rule shown below is included in the SPOT-OUT expert system:

ADVICE Spray with hair-spray and wash as normal (80%)
 IF Stain is due to ink
 AND Stain is on fabric.

Haymon uses the expert system to get advice about how to deal with an ink stain on his shirt. He provides the expert system with the following information:

The stain is due to ink:

Certainty Factor: 50% 60% 70% 80% 90% 100%

The stain is due to grease:

Certainty Factor: 50% 60% 70% 80% 90% 100%

The stain is on fabric:

Certainty Factor: 50% 60% 70% 80% 90% 100%

The stain is on upholstery:

Certainty Factor: 50% 60% 70% 80% 90% 100%

Calculate the certainty of the conclusion:

Spray with hair-spray and wash as normal.

You should show all working.

2

(c) Users of the SPOT-OUT expert system can ask for justification of any advice that is suggested. Explain how the expert system would justify any advice that it suggests.

2

[END OF SECTION II – PART B]

(50)

[Turn over

Part B – Expert Systems

Attempt ALL questions in this part.

25. Computer-based information systems such as expert systems and decision support systems are often used by companies to automate the planning of business activities and events.
- (a) Distinguish between an *expert system* and a *decision support system*. 4
- (b) The STRIPS expert system was developed in the early 1970s. Describe this expert system in terms of *category* and main *characteristics*. 3
26. Tom is interested in sailing and has decided to make an expert system regarding pleasure boats. He has consulted an expert and received the following advice.
- Expert: Pleasure boats are boats used by people for their enjoyment and leisure.
 A pleasure boat powered by humans using oars is a rowing boat.
 A pleasure boat powered by an engine is known as a powerboat. When the engine is mounted outside the stern of the boat this is an outboard engine. An engine inside the hull of the boat is an inboard engine.
 A pleasure boat powered by wind is a sailboat.
- (a) Make up design rules to represent the knowledge from the expert. The rules should be expressed in a form with which you are familiar, as shown in the first two rules below:
- If boat is used for enjoyment and leisure THEN vessel is pleasure boat.
 If vessel is pleasure boat and power is by humans using oars THEN this boat is a rowing boat. 4
- (b) State the category of this expert system. Justify your answer. 2
- (c) Certainty factors are often features of expert systems.
- (i) Describe **two** benefits that can be claimed for an expert system that implements certainty factors. 2
- (ii) Give **two** reasons why some expert systems do not use certainty factors. 2
- (d) This is an example of a *forward chaining* rule-based expert system.
- (i) Explain why *conflict resolution strategies* are required in expert systems such as this. 2
- (ii) What is the purpose of the RETE algorithm? 2
- (iii) Describe how the *refractoriness* strategy for conflict resolution works. 2

Part B – Expert Systems (continued)

27. CITYCAR is a small company selling small four wheel vehicles for city travellers to use throughout Scotland. Customers who purchase a vehicle are asked if they wish to purchase an extended service warranty. For the duration of its extended warranty, customers who have any problems with a vehicle purchased from CITYCAR can call out a service engineer. The service engineer will then arrange a suitable date and time to call at the customer's home to repair the vehicle.

The IT department at CITYCAR is developing a fault diagnosis expert system for use by the service engineers. The expert system will run on laptop computers that the service engineers can take to a customer's house when on a service call. The service engineer will be able to use the expert system to help identify the source of any fault. The expert system will also be able to provide guidance about any repairs that are needed.

- (a) Identify **two** benefits of developing an expert system for this purpose. 2

- (b) Several of the service engineers who work for CITYCAR are concerned about what happens if the expert system misdiagnoses a fault in a vehicle and they then follow any inaccurate guidance that is subsequently provided by the expert system.

Who is responsible for any bad advice that is provided by an expert system? Justify your answer. 2

- (c) As the expert system is being developed, it is possible that errors could occur at each stage of its development. Describe **one** source of an error that could occur during **each** of the following stages of development:

- (i) Knowledge acquisition 1

- (ii) Knowledge representation 1

- (d) Compare an expert system with a relational database management system in terms of –

- Representation of data/knowledge
- Extraction of data/knowledge

Use your comparison to justify why the IT Manager at CITYCAR decided to develop an expert system rather than develop a relational database system for the vehicle fault diagnosis system. 4

[Turn over

Part B – Expert Systems (continued)

28. An expert system is being developed to identify and classify geographical features. The following knowledge is to be stored in the knowledge base of the expert system:

A landform is a part of the terrain and is categorised by its elevation, slope and position. A mountain is a landform that extends above the surrounding terrain and has steep cliffs. A gorge is a landform which extends beneath the surrounding terrain and has steep cliffs. A gorge is formed by erosion. A valley is a depression between two mountains. A river valley is formed by a river. A glacial valley is formed by a glacier.

- (a) Derive *attribute pairs* from this information about geographical features provided above. The attribute pairs should be in the form:

landform(part_of_terrain, has_elevation, has_slope, has_position)
 mountain(landform, extends_above_terrain, has_steep_cliffs)

5

- (b) The developers of the expert system decide to represent knowledge about glacial moraines as *factor tables*. The factor tables are shown below.

Formed by Glacier	From Debris	Classification
Yes	Yes	Moraine

Moraine	Subglacial	Raised Feature	Classification
Yes	No	No	Terminal Moraine
Yes	No	Yes	Lateral Moraine
Yes	Yes	No	Ground Moraine
Yes	Yes	Yes	Ribbed Moraine

- (i) Represent the factor tables above as a *decision tree*. 4
- (ii) Compare the use of factor tables and a decision tree to represent the knowledge about glacial moraines. 2
- (c) One developer is proposing that the system be developed as a deductive database. Explain what is meant by a deductive database. 2
- (d) An expert system can be forward or backward chaining.
- (i) How does the *inference engine* in a *backward chaining* expert system operate? 2
- (ii) The following information is used to identify some mountain features.

A	An arête is a thin ridge of rock between two valleys
B	A plateau is a raised area of land consisting of a flat region

Produce *backward* rules that represent the knowledge contained in statements A and B above. 2

[END OF SECTION II – PART B]

(50)

SECTION III

Part B – Expert Systems

Marks

Attempt ALL questions in this part.

22. Northania is an island which is a popular destination for scuba divers. Around the coast there are many dive sites, each offering divers a particular attraction. One of the local dive companies has developed an expert system to try to ensure that divers get those dives which they would most enjoy. Information about some of the dive sites is shown in the following expert system rules.

IF you want to see sharks
THEN you will enjoy Big Tooth Bay (0.6)

IF you want to visit a wreck
THEN you will enjoy Poseidon Dive (0.8)

IF you want to see black coral AND
you would like a deep dive
THEN you will enjoy Antonio's Canyon (0.8)

IF you would like to drift with the current
THEN you will enjoy Long Reef (0.9)

IF you would like to see sting rays AND
you would like to see black coral
THEN you will enjoy Ray City (0.7)

A diver was asked about her preferences for dives and gave answers with the following certainty factors:

like to visit a wreck 0.5
like to see sting rays 0.7
like to see black coral 0.9
like to do a deep dive 0.6

- (a) (i) Calculate the certainty of the conclusion that the diver would enjoy Antonio's Canyon. 2
- (ii) Which conclusion will be reached for the given facts? Explain your answer. 4
- (iii) When asked, a diver said that he would very much like to carry out a drift dive. State a suitable certainty factor which could be allocated to this answer. 1
- (b) The expert system uses *forward chaining*. In a forward chaining expert system:
- (i) explain what is meant by the working memory. 2
- (ii) explain what is meant by a *conflict set*. 2
- (iii) describe how the *specificity* conflict resolution strategy works. 2

[Turn over

Part B – Expert Systems (continued)

23. Ferve Micros is a small manufacturer of laptop computers. Features of a sample of the computers it produces are shown in the table below.

	Low Weight	Wide Screen	Long Battery Life	High Speed Processor
LF 600		•	•	•
LF400	•	•		
NM200	•	•	•	
NM400	•		•	•

• indicates the laptop has this feature

To help customers choose which laptop may suit them best Ferve Micros has developed an expert system. Some of the rules from the expert system are shown below:

IF weight IS low AND
battery life IS long
THEN type is NM.

IF type IS NM AND
screen IS wide
THEN advice IS buy NM200.

IF screen IS wide AND
battery life IS long AND
processor speed IS high
THEN advice is buy LF600.

- (a) Write rules to give advice to buy LF400 and NM400 using forward chaining as above. 4
- (b) Rewrite the rule giving the advice to buy NM200 in backward chaining form. 1

Part B – Expert Systems (continued)

24. CallsforYou is a business selling mobile telephones and call plans. The company has recently introduced an expert system to assist customers in selecting the call plan which best suits their needs. This is available on the company's website. One of the screens from the system is shown below.
- (a) State **two** cost factors CallsforYou would have considered before proceeding with the development of the expert system. 2
- (b) Describe the **three** components of an expert system. 6
- (c) The results of a user's consultation are selected from a database. Compare a database management system and an expert system in terms of how data is represented. 2
- (d) A programmer was one of the personnel involved in the production of this expert system. Name **two** other personnel involved in the production of expert systems and describe the role performed by **each**. 6
- (e) Anita uses the expert system and purchases the call plan recommended. After 3 months she discovers that although she does not use her phone any more than previously her bills are now consistently higher. Two of the people responsible for Anita having higher bills now may have been the programmer and/or Anita.
- Describe how **each** of them may have caused the expert system to advise an apparently unsuitable call plan. 6
25. Doonbrae Fitness operates a chain of 5 fitness centres and gyms. The company is considering having an expert system developed to help with the organisation of fitness classes and allocating instructors to these classes.
- (a) State **two** factors which may make a subject suitable for the development of an expert system. 2
- (b) The statement that Callum is qualified to teach bodypump classes can be represented by the predicate:
qualified (callum, bodypump)
- Represent the statement that Andrew is qualified to teach cyclespin and trimtome in predicate logic. 2
- (c) Describe **one** difference in the results presented to a user from a decision support system and an expert system. 2
- (d) State **four** features of an expert system which may be used to evaluate the system. 4
- (50)
- [END OF SECTION III – PART B]

SECTION III

Part B – Expert Systems

Marks

Attempt ALL questions in this part.

21. A golf travel company has developed an expert system to help select courses for tourists. Most tourists want to play a selection of inland parkland courses and seaside links courses. The expert system is designed to help golfers of all ability ranges by including information on how difficult each course is by giving a recommended maximum handicap.

Here are some of the rules which are used to determine the advice given.

IF round preference IS links
AND cost of round IS < £40
Then play Steenhive course (0.7).

IF round preference IS parkland
AND recommended maximum handicap IS 24
AND cost of round IS <£40
THEN play Inverwick course (0.8).

IF round preference IS links
AND recommended maximum handicap IS 18
THEN play Murlorrie course (0.8).

The following facts are known with the certainty factors given.

Round preference is links	0.7
Round preference is parkland	0.8
Cost of round is <£40	0.9
Recommended maximum is 24	0.8
Recommended maximum is 18	0.5

- (a) Calculate the certainty of the conclusion that the player will play Murlorrie course. Show your working. 2
- (b) Which course would the expert system give from the given facts? Explain your answer. 4
- (c) Rewrite the rule above giving the advice to play Inverwick course in backward chaining form (ignore the certainty factor). 2

Part B – Expert Systems (continued)

22. Distinguish between an expert system and a relational database in terms of how the information is extracted 4

23. Information about pupils and their schools can be represented as a series of predicates, as follows:

Predicate	Statement
lives-in(john,lowtown,walks)	John lives in Lowtown and walks to school
pupil-in(mary,ayton-academy)	Mary is a pupil in Ayton Academy

Represent the following statements in predicate logic:

(i) Alan lives in Hightown, cycles to school and is a pupil in Inverdeen Academy. 2

(ii) Anyone in Deeville who walks to school goes to Brewerly Academy 3

24. A *forward chaining* expert system contains the following rules where the letters A to J represent facts which are known or can be concluded.

1. If A and B then C
2. If A and D then E
3. If B and F then G
4. If A and B and G then H
5. If B and D and H then J

Suppose working memory contains the facts A, B and F, added in that order.

(a) (i) List the rules which exist in the *conflict set*. 3

(ii) Using *recency* conflict resolution strategy, state which rule would be fired first. 2

(iii) Describe how the *refractoriness* conflict resolution strategy works. 2

(b) What is the purpose of the *RETE algorithm*? 2

(c) The following rule was added to the expert system. Represent this rule using *propositional logic*.

If B and not G then K 3

[Turn over

25. The following factor table is taken from an expert system used to identify birds of the Finch family.

Length	Bill colour	Breast colour	Finch
14-16cm	pinkish	brown	Chaffinch
14-16cm	yellow	orange	Brambling
12-13cm	grey	green	Greenfinch
12-13cm	grey	white	Goldfinch
12-13cm	yellow	red	Redpoll
10-11cm	grey	brown	Linnet
10-11cm	grey	yellow	Siskin

(a) Use the above table to create a *rule tree* using Length as the root. 7

(b) Write rules to represent the knowledge for the members of the finch family who have a brown or orange breast. 6

26. (a) An expert system is a computer program which stores information in order to solve problems and give advice to humans

(i) State **two** benefits of using an expert system. 2

(ii) State **two** limitations of using an expert system. 2

(b) (i) Describe the ONCOCIN expert system in terms of its *domain* and *category*. 2

(ii) One of the main characteristics of the ONCOCIN expert system was that the domain expert could enter the knowledge directly by means of an interview system at the computer terminal thereby doing away with the need for knowledge engineers. Sources of error may, however, still exist in this system.

State where **two** sources of errors may still exist in the system. 2

[END OF SECTION III – PART B]

(50)