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|  | | | | | | |  |  | **Sakrekenaars/Calculators:** | **Nee/No** |  |
| **Benodigdhede vir hierdie vraestel/Requirements for this paper:** | | | | | | |  |  | **Ander hulpmiddels/Other resources:** | |  |
|  | **Antwoordskrifte/**  **Answer scripts:** | **X** |  | **Multikeusekaarte (A5)/**  **Multi-choice cards (A5):** |  |  |  |  |  | |  |
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|  | **Presensiestrokies (Invulvraestel)/**  **Attendance slips (Fill-in paper):** |  |  | **Multikeusekaarte (A4)/**  **Multi-choice cards (A4):** |  |  |  |  |  | |  |
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|  | **Rofwerkpapier/**  **Scrap paper:** |  |  | **Grafiekpapier/**  **Graph paper:** |  |  |  |  |  | |  |
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| **Tipe Assessering/**  **Type of Assessment:** | **Eksamen 1e geleentheid**  **Exam 1st opportunity**  **Vraestel/Paper 1** | **Kwalifikasie/**  **Qualification:** | **B.Sc. Honns** |
| **Modulekode/**  **Module code:** | **ITRI626** | **Tydsduur/**  **Duration:** | **3 uur**  **3 hour** |
| **Module beskrywing/**  **Module description:** | **Kunsmatige Intelligensie / Artificial Intelligence** | **Maks/**  **Max:** | **100** |
| **Eksaminator(e)/**  **Examiner(s):** | **Dr. J. V. (Tiny) du Toit** | **Datum/**  **Date:** | **01/11/2017** |
| **Interne/Internal**  **Moderator(s):** | **Mnr. H. Foulds** | **Tyd/**  **Time:** | **09:00** |

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| **Inhandiging van antwoordskrifte/Submission of answer scripts:** | **Gewoon/Ordinary** |

**Vraag 1 (Logiese Agente) / *Question 1 (Logical Agents)***

1.1 Gee die vier stappe om enige logiese uitdrukking in Proposisielogika om te skakel na Konjunkte normaalvorm (KNV).

*Give the four steps to convert any logical expression in Propositional Logic into Conjunctive normal form (CNF).* [10]

Step 1. Eliminate ⇔, replacing α ⇔ β with (α ⇒ β) ∧ (β ⇒ α). (3)

Step 2. Eliminate ⇒, replacing α ⇒ β with ¬α ∨ β. (2)

Step 3. CNF requires ¬ to appear only in literals, so we “move ¬ inwards” by repeated application

of the following equivalences:

¬(¬α) ≡ α (double-negation elimination)

¬(α ∧ β) ≡ (¬α ∨ ¬β) (De Morgan)

¬(α ∨ β) ≡ (¬α ∧ ¬β) (De Morgan) (3)

Step 4. Now we have a sentence containing nested ∧ and ∨ operators applied to literals. (2)

1.2 Skakel die volgende logiese uitdrukking om in Konjunkte normaalvorm (KNV). Toon al jou redenasiestappe aan.

*Convert the following logical expression into Conjunctive normal form (CNF). Show all you reasoning steps.* [12]

¬T ⋁ Q ⇒ S ⋀ R

¬(¬T ⋁ Q) ⋁ (S ⋀ R) (Eliminate ⇒)

(T ⋀ ¬Q) ⋁ (S ⋀ R) (Move ¬ invards)

(T ⋁ (S ⋀ R)) ⋀ (¬Q ⋁ (S ⋀ R)) (Distribute ⋁ over ⋀)

(T ⋁ S) ⋀ (T ⋁ R) ⋀ (¬Q ⋁ S) ⋀ (¬Q ⋁ R) (Distribute ⋁ over ⋀)

Trying something: 4 marks.

Performing the conversion to CNF steps: 6 marks.

Performing the conversion to CNF steps and naming the steps: 12 marks.

1.3 Bepaal of elkeen van die volgende Proposisielogika sinne bevredigbaar, onbevredigbaar of geldig is. Toon all jou redenasiestappe aan.

*Determine whether each of the following Propositional Logic sentences is satisfiable, unsatisfiable, or valid. Show all your reasoning steps.*

1. Q ⋀ True (Bevredigbaar / Satisfiable) – At least one model is true. [3]

|  |  |  |
| --- | --- | --- |
| Q | True | Q ⋀ True |
| T | T | T |
| F | T | F |

1. (S ⇒ Q) ⇒ ¬S (Bevredigbaar / Satisfiable) – At least one model is true. [5]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S | Q | ¬S | S ⇒ Q | (S ⇒ Q) ⇒ ¬S |
| T | T | F | T | F |
| T | F | F | F | T |
| F | T | T | T | T |
| F | F | T | T | T |

1. (P ⇒ S) ⇒ (¬P ⋁ S) (Geldig / Valid) – All models are true. [5]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| P | S | ¬P | (P ⇒ S) | (¬P ⋁ S) | (P ⇒ S) ⇒ (¬P ⋁ S) |
| T | T | F | T | T | T |
| T | F | F | F | F | T |
| F | T | T | T | T | T |
| F | F | T | T | T | T |

1. P ⋁ Q ⋁ R ⋁ S ⋁ False (Bevredigbaar / Satisfiable) – At least one model is true. [5]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| P | Q | R | S | False | P ⋁ Q ⋁ R ⋁ S ⋁ False |
| T | T | T | T | F | T |
| T | T | T | F | F | T |
| T | T | F | T | F | T |
| T | T | F | F | F | T |
| T | F | T | T | F | T |
| T | F | T | F | F | T |
| T | F | F | T | F | T |
| T | F | F | F | F | T |
| F | T | T | T | F | T |
| F | T | T | F | F | T |
| F | T | F | T | F | T |
| F | T | F | F | F | T |
| F | F | T | T | F | T |
| F | F | T | F | F | T |
| F | F | F | T | F | T |
| F | F | F | F | F | F |