Register Number | | | | | | | | |

Sri Sivasubramaniya Nadar College of Engineering, Kalavakkam – 603 110

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Department of Computer Science and Engineering

Continuous Assessment Test – I

Answer Key

<table>
<tr><td>Degree & Branch</td><td colspan="3">B.E & CSE</td><td>Semester</td><td colspan="2">V</td></tr>
<tr><td>Subject Code & Name</td><td colspan="3">UCS1524 – Logic Programming</td><td>Regulation:</td><td colspan="2">2018</td></tr>
<tr><td>Academic Year</td><td>2022-2023 (Odd)</td><td>Batch</td><td>2020-2024</td><td>Date</td><td>22-9-22</td><td>FN</td></tr>
<tr><td>Time: 8.15 to 9.45</td><td colspan="4">Answer All Questions</td><td colspan="2">Maximum: 50 Marks</td></tr>
</table>

Part – A (6×2 = 12 Marks)

<table>
<tr><th>K Level</th><th>Questions</th><th>COs</th><th>PIs</th></tr>
<tr><td>KL2</td><td>1. Compare propositional logic and predicate logic.
<table>
<tr><td>S.No</td><td>propositional logic</td><td>and predicate logic</td></tr>
<tr><td>1</td><td>declarative</td><td>Non declarative</td></tr>
<tr><td>2</td><td>Context independent</td><td>Context sensitive</td></tr>
<tr><td>3</td><td>Less expressive</td><td>More expressive</td></tr>
<tr><td>4</td><td>Supports conjunction, disjunction, negation, implies and equivalence</td><td>In addition, existential and universal quantifiers are used</td></tr>
</table></td><td>CO1</td><td>1.1.1</td></tr>
<tr><td>KL1</td><td>2. Find the semantics of the formula: $\neg P \wedge (P \rightarrow Q)$
Satisfiable</td><td>CO1</td><td>1.1.1</td></tr>
<tr><td>KL3</td><td>3. Identify whether the following two formulas are closed. Justify your answer.
i. $\forall x\, (\exists y\, r(x, f(y)) \rightarrow r(x, y))$
ii. $\forall z\, \exists x\, \exists y\, (q(z, u, g(u, y)) \vee r(u, g(z, u)))$
Both are not closed i. y is free, ii. U is free</td><td>CO1</td><td>1.3.1</td></tr>
<tr><td>KL3</td><td>4. Let A is “there is rain” and B is “climate is cool”. Use propositional logics to convert the statement: “If there is rain, the climate is cool and if the climate is cool then there is a rain” into CNF form.
$(\neg A \vee B) \wedge (\neg B \vee A)$</td><td>CO1</td><td>1.1.1
2.1.3
13.1.2</td></tr>
<tr><td>KL3</td><td>5. Represent the statements: “The cake is either fresh or not tasty” and “The cake is neither fresh nor tasty” using horn formula.
(B -> A) ^ (A ^B -> 0)</td><td>CO1</td><td>1.3.1
13.1.2</td></tr>
<tr><td>KL2</td><td>6. What is unit resolution? Illustrate with an example.
One of the parent clauses must be unit clause
F={{p,q}, {¬p, r}, {¬q,r}, {¬r}}
¬p, r ¬r -> ¬p
¬q, r ¬r -> ¬q
p, q ¬p -> q
¬q q -> null</td><td>CO1</td><td>1.3.1</td></tr>
</table>

Part – B (3×6 = 18 Marks)

KL2	7. Show that the following two formulas are equivalent. i. ((A V (B V C)) ^ (C V ⌐A)) ii. ((B ^ ⌐ A) V C)	CO1	2.1.3

<table>
<tr>
<td></td>
<td>$((A \lor (B \lor C)) \land (C \lor \neg A))$
$\equiv (((A \lor B) \lor C) \land (C \lor \neg A))$ (Associativity and ST)
$\equiv ((C \lor (A \lor B)) \land (C \lor \neg A))$ (Commutativity and ST)
$\equiv (C \lor ((A \lor B) \land \neg A))$ (Distributivity)
$\equiv (C \lor (\neg A \land (A \lor B)))$ (Commutativity und ST)
$\equiv (C \lor ((\neg A \land A) \lor (\neg A \land B)))$ (Distributivity and ST)
$\equiv (C \lor (\neg A \land B))$ (Unsatisfiability Law and ST)
$\equiv (C \lor (B \land \neg A))$ (Commutativity and ST)
$\equiv ((B \land \neg A) \lor C)$ (Commutativity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KL2</td>
<td>8. Show the CNF forms of the following propositional logic formulas
i. (P→Q) →R
ii. (R→S) → ¬ (S→Q)
<table>
<tr>
<td>(P→Q) →R
¬ (¬ P V Q) V R
(P ^ ¬Q) V R
(P V R) ^ (¬Q V R)</td>
<td>(R→S) → ¬ (S→Q)
¬ (¬ R V S) V ¬ (¬ S V Q)
(R ^ ¬ S) V (S ^ ¬ Q)
(R V S) ^ (R V ¬ Q) ^ (¬S V S) ^ (¬S V ¬Q)
(R V S) ^ (R V ¬ Q) ^ (¬S V ¬Q)</td>
</tr>
</table>
</td>
<td>CO1</td>
<td>1.1.1
2.1.3</td>
</tr>
<tr>
<td>KL2</td>
<td>9. Explain the steps to convert a FOL formula into clausal form with an example.
1. Eliminate implies and equivalence
2. Eliminate negations
3. Standardize variables (rectification)
4. Skolemization
5. Convert formula to prenex form
6. Drop universal quantifiers
7. Apply distributive law to convert into CNF form</td>
<td>CO1</td>
<td>2.1.2</td>
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</table>

Part – C (2×10 = 20 Marks)

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<tr>
<td><KL3></td>
<td>10. Consider the following FOL formulas.
i. ∃x Kitten (x) ^ Has (Anu, x)
ii. ∀x (∃y Kitten (y) ^ Has (x,y)) → Animal_Lover(x)
iii. ∀x Animal_Lover (x) → ∀y Animal(y) → ¬Hurts (x,y)
iv. Hurts (Anu, Ram) V Hurts (Sanjay, Ram)
v. Puppy (Ram)
vi. ∀x Puppy (x) → Animal (x)

Apply resolution and show the inference of Hurts(Sanjay, Ram) follows a N-resolution.

Clausal forms
Kitten(x)
Has (Anu, x)
¬Kitten(y) v ¬Has(x,y)) v Animal_Lover(x)
¬Animal_Lover (x) v ¬Animal(y) v ¬Hurts(x,y)
Hurts (Anu, Ram) V Hurts (Sanjay, Ram)
Puppy(Ram)
¬Puppy (x) v Animal (x)

Refutation
¬Hurts (Sanjay, Ram) Hurts (Anu, Ram) V Hurts (Sanjay, Ram)
Hurts (Anu, Ram) ¬Animal_Lover (x) v ¬Animal(y) v ¬Hurts(x,y) x/Anu, y/Ram
¬Animal_Lover (Anu) v ¬Animal(Ram) ¬Kitten(y) v ¬Has(x,y)) v Animal_Lover(x) x/Anu, y/Ram
¬Kitten(Ram) v ¬Has(Anu,Ram) v ¬Animal(Ram) Kitten(x) x/Ram
¬Has(Anu,Ram) v ¬Animal(Ram) Has (Anu, x) x/Ram
¬Animal(Ram) ¬Puppy (x) v Animal (x) x/Ram
¬Puppy (Ram) Puppy(Ram)
null</td>
<td>CO1</td>
<td>1.4.1
2.1.2</td>
</tr>
</table>

	In each step of refutation, one of the parent clauses is negative. Thus, it holds N-resolution.		
(OR)			
<KL3>	11. Consider the following FOL formulas. The first four are premises and the last formula is a conclusion. i. ∀ x (HOUND(x) → HOWL(x)) ii. ∀ x ∀ y (HAVE (x, y) ∧ CAT (y) → ¬ ∃ z (HAVE (x, z) ∧ MOUSE (z))) iii. ∀ x (LS(x) → ¬ ∃ y (HAVE (x,y) ∧ HOWL(y))) iv. ∃ x (HAVE (John, x) ∧ (CAT(x) ∨ HOUND(x))) v. LS(John) → ¬ ∃ z (HAVE (John, z) ∧ MOUSE(z)) Apply resolution to show whether the conclusion is valid. What type of constraints you use in this resolution. **Clausal Forms** ¬ HOUND(x) ∨ HOWL(x) ¬ HAVE(x,y) ∨ ¬ CAT(y) ∨ ¬ HAVE(x,z) ∨ ¬ MOUSE(z) ¬ LS(x) ∨ ¬ HAVE(x,y) ∨ ¬ HOWL(y) HAVE(John,a) CAT(a) ∨ HOUND(a) **Negated conclusion** LS(John) HAVE(John,b) MOUSE(b) ¬ HAVE(x,y) ∨ ¬ CAT(y) ∨ ¬ HAVE(x,z) ∨ ¬ MOUSE(z) MOUSE(b) z/b ¬ HAVE(x,y) ∨ ¬ CAT(y) ∨ ¬ HAVE(x,b) ¬ HAVE(x,y) ∨ ¬ CAT(y) ∨ ¬ HAVE(x,b) HAVE(John,b) x/John ¬ HAVE(John,y) ∨ ¬ CAT(y) ¬ HAVE(John,y) ∨ ¬ CAT(y) CAT(a) ∨ HOUND(a) y/a ¬ HAVE(John,a) ∨ HOUND(a) ¬ HAVE(John,a) ∨ HOUND(a) ¬ HOUND(x) ∨ HOWL(x) x/a ¬ HAVE(John,a) ∨ HOWL(a) ¬ HAVE(John,a) ∨ HOWL(a) HAVE(John,a) HOWL(a) HOWL(a) ¬ LS(x) ∨ ¬ HAVE(x,y) ∨ ¬ HOWL(y) y/a ¬ LS(x) ∨ ¬ HAVE(x,a) ¬ LS(x) ∨ ¬ HAVE(x,a) HAVE(John,b) x/John ¬ LS(John) ¬ LS(John) LS(John) null Linear Resolution is used in this	CO1	1.4.1 2.1.2
<KL3>	12. Consider the following premises. i. Anyone who does not sing is not a singer. ii. Anyone whom Anu likes is a singer. iii. Any artist who does not like cinema does not sing. iv. Any artist who does not enjoy does not like cinema. v. If Ram does not enjoy, then Anu does not like Ram Construct FOL formulas and clausal forms for the above statements. **FOL** i. Anyone who does not sing is not a singer. *∀x (¬ SING(x) → ¬ SINGER(x))* ii. Anyone whom Anu likes is a singer. *∀x (LIKES(Anu,x) → SINGER(x))* iii. Any artist who does not like cinema does not sing. *∀x (ARTIST(x) ∧ ¬ LIKE_CINEMA(x) → ¬ SING(x))* iv. Any artist who does not enjoy does not like cinema. *∀x (ARTIST(x) ∧ ¬ ENJOY(x) → ¬ LIKE_CINEMA (x))* v. If Ram does not enjoy, then Anu does not like Ram *¬ ENJOY(Ram) → ¬ LIKES(Anu,Ram)*	CO1	2.1.3 2.4.1 13.1.2

Clausal form
sing(w)v~ singer (w)
~likes(Anu, x) v singer(x)
~artist(y)vlike_cinema(y)v~sing(y)
~artist(z)v enjoy(z) v ~like_cinema (z)
~ enjoy(Ram) v ~like(Anu, Ram)

(OR)

<KL3> | CO1 | 2.1.3, 2.4.1, 13.1.2

13. Vidhya has two books ‘TOC’ and ‘AI’. She needs to write exam. The 4 facts are given below.
    a. Vidhya reads ‘TOC’ book
    b. Vidhya does not read ‘AI’ book
    c. If Vidhya reads ‘TOC’ book, she can write the exam
    d. If Vidhya reads ‘TOC’ book and she writes the exam, then she has also read the ‘AI” book.

i. Construct horn formulas in propositional logic for the above facts and check whether the facts are satisfiable or not (Show each of the iterations). (5)
ii. Check for the satisfiability using truth table by considering all the four facts. (5)

i. Let A=Vidhya reads TOC book, B=Vidhya reads AI book, C=she writes exam
a. A
b. ~B
c. A->C
d. A ^ C -> B

Horn Formula

1. **(1->A)** (B->0)(A->C)(A^C ->B) A is marked
2. (1->A) (B->0**)(A->C)(**A^C ->B) C is marked
3. (1->A) (B->0)(A->C)**(A^C ->B)** B is marked
4. (1->A) (**B->0**)(A->C)(A^C ->B) 0 is marked, thus unsatisfiable

ii. Truth Table

A	B	C	~B	A->C	A^C	A ^ C -> B	F
0	0	0	1	1	0	1	0
0	0	1	1	1	0	1	0
0	1	0	0	0	0	1	0
0	1	1	0	1	0	1	0
1	0	0	1	1	0	1	0
1	0	1	1	1	1	0	0
1	1	0	0	0	0	1	0
1	1	1	0	1	1	1	0

Unsatisfiable

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