NOTE THIS IS A PRACTICE EXAM – THE ACTUAL EXAM WILL BE IN THE SAME FORMAT. HOWEVER, THIS PRACTICE EXAM IS LONGER AND (SLIGHTLY) MORE DIFFICULT THAN THE FINAL EXAM WILL BE

A) Categorical Logic

Each question in this section is worth 3 points

Use Venn diagrams to determine the validity of the following arguments:

1. All fast-food items are overpriced objects. No overpriced objects are nutritious products. Therefore, no nutritious products are fast-food items.

2. Some vegetables are not tasty foods. Therefore, some tasty foods are not green foods, because some vegetables are not green foods.

3. All mechanical objects are noisy objects. All airplanes are noisy objects. Thus, all airplanes are mechanical objects.

4. Some pens are not useful tools. This is because some pens are leaky writing implements, and no leaky writing implements are useful tools.

5. No septic tanks are swimming pools. No sewers are swimming pools. Therefore, no septic tanks are sewers.

6. All voice messages are distracting pieces of information. Some games people play are distracting pieces of information. So, some voice messages are games people play.

7. Some universities are not expensive places to attend. Some universities are conveniently located complexes. Thus, some expensive places to attend are not conveniently located complexes.

8. No sports fanatics are rational creatures. Therefore, no sports fanatics are benevolent people, since all rational creatures are benevolent people.

9. Some buildings are poorly constructed domiciles. Some buildings are architectural nightmares. So, some architectural nightmares are poorly constructed domiciles.

*B) Propositional Logic - Translations*____

Each question in this section is worth 4 points

Translate the following texts into Propositional logic. For each,

- Provide a legend to establish what your propositional variables refer to
- Symbolize text into PL using propositional variables, and symbols (i.e., ⊃, •, v, ~, ≡)
  - You may use any of the common alternative notations as follows:
    - → can be used in place of ⊃
    - ¬ can be used in place of ~
    - ∧, & can be used in place of •
    - ↔ can used in place of ≡
- Symbolizations should consist of 3 lines, expressing one formula each
  - 1 formula per sentence of text (the formulae may be atomic or complex)
- **NOTE!** All the propositions in your legend must be affirmative. If need be, use negation (~) in your symbolization to represent negative claims

1. If it's a leap year, then someone is going to be born on a strange day. If either someone is born on a strange day, or it is not a leap year, then we'll have a reason to stay calm. We don't have a reason to stay calm.

2. We will be fine or Taylor Swift will release another song. If she releases another song, we will not be fine, but she's not going to release another song. So, we will be fine.

3. Everything is amusing, and everything is tragic. Life is weird. Life is weird if and only if everything is amusing or everything is tragic.

4. If logic class was fun, I wouldn't need to ask if it is fun. I don't need to ask if logic class is fun, and fun is not important. Thus, logic class is fun, but fun is important.

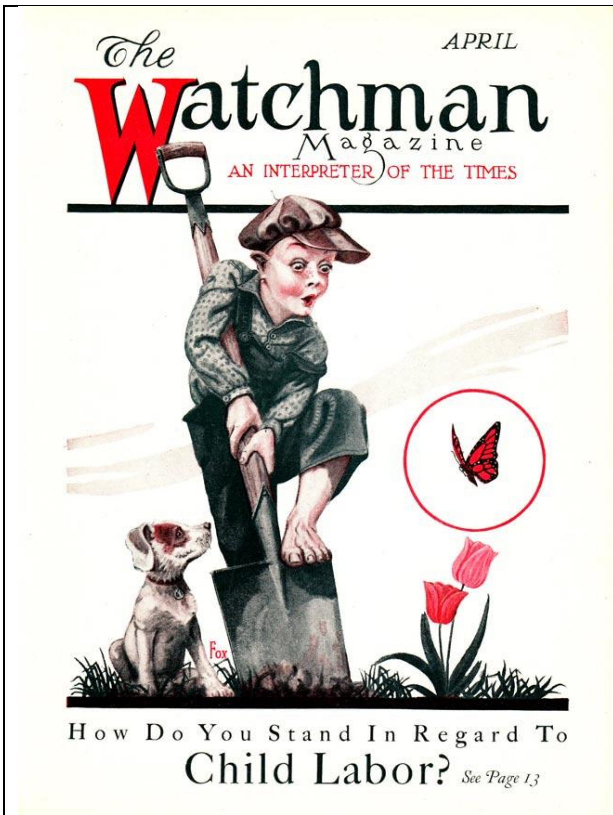
C) Propositional Logic – Truth Values ____

Each question in this section is worth 4 points

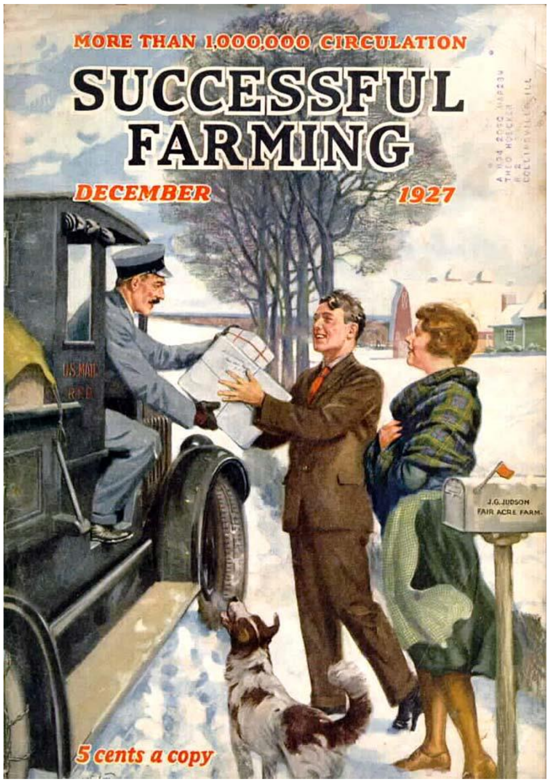
Each question below is paired with an image that determines truth values for the relevant propositions.

- Provide a legend to establish what your propositional variables refer to
- Symbolize text into PL using propositional variables, and symbols (i.e., ⊃, •, v, ~, ≡)
    - You may use any of the common alternative notations as follows:
        - → can be used in place of ⊃
        - ¬ can be used in place of ~
        - ∧, & can be used in place of •
        - ↔ can used in place of ≡
- Determine the type of formula
- Determine the truth value of the formula

1.

	If the boy is holding a shovel and there is a butterfly nearby, then there are 3 roses nearby. Legend: Symbolization: Formula type: Truth Value:

2.



If there is a package changing hands, then there is a dog nearby, or if there is snow on the ground, then it is not true that there is a tree nearby.

Legend:

Symbolization:

Formula type:

Truth Value:

3.

The man is wearing a hat or he is not wearing a scarf, and if he is not wearing glasses the eggs are not falling out of his bucket.

Legend:

Symbolization:

Formula type:

Truth Value:

D) Propositional Logic – Truth Tables ____

For each formula below, produce a full truth table, and identify the main operator

each question is /12

- Note, the grids below may provide more rows and columns than are required

1. (~R ∨ S) • (~ T ⊃ R)

2. [U ⊃ (V ⊃ W)] • (V ∨ W)

3. [~ X ≡ (Y•Z)] ⊃ (X ∨ Z)

E) Propositional Logic – Derivations 1 – Inference ________________________________

These derivations *can* be completed using just the rules of inference. However, you may also use the rules of equivalence, and/or the methods of conditional proof and indirect proof, if you wish.

*****Note that there is a list of all the rules of inference and all the rules of equivalence at the end of the exam, which you can tear off*****

1.

1. Q ⊃ (~R ⊃ S)
2. T ∨ Q
3. ~T
4. R ⊃ T / S

2.

1. V ⊃ (W ∨ U)
2. X ∨ V
3. X ⊃ Y
4. ~Y
5. ~Y ⊃ ~W / U

3.

1. A ⊃ B
2. B ⊃ (C ⊃ D)
3. E ∨ C
4. E ⊃ F
5. ~F
6. C ⊃ A / D

4.

1. Q ⊃ (~R ⊃ S)
2. T ∨ Q
3. ~T
4. R ⊃ T / S

5.

1. P ⊃ (Q ⊃ ~U)
2. R ⊃ (Q ⊃ S)
3. (P ∨ R) • T
4. ~(Q ⊃ ~U)
5. Q / S ∨ ~U

F) Propositional Logic – Derivations 2 – Inference + Equivalence ___________________

These derivations *can* be completed using just the rules of inference and equivalence. However, you may also use the methods of conditional proof and/or indirect proof, if you wish.

1.
 1. ~D • ~E
 2. (D ∨ F) ∨ E / F

2.
 1. I • {~[J • (K ∨ L)] • M}
 2. (~J ∨ ~L) ⊃ N / N

3.
 1. [O ∨ (P • Q)] ⊃ R
 2. R ⊃ ~S
 3. P • S / ~Q

4.
 1. (S ∨ C) ∨ (I ∨ N)
 2. (S ∨ C) ⊃ U
 3. I ⊃ C
 4. ~U / ~(U ∨ ~N)

5.
 1. Q ⊃ R
 2. R ⊃ (S ⊃ T) / ~T ⊃ (S ⊃ ~Q)

6.
 1. (P ≡ Q) ∨ P / P ∨ ~Q

G) Propositional Logic – Derivations 3 – All techniques ____________________________

These derivations *can* be completed using the rules of inference and/or equivalence and/or the methods of conditional proof and/or indirect proof.

1. 1. Q ⊃ (~R • S) / R ⊃ ~Q

2 . 1. ~M ∨ N
2. P / (M ∨ ~P) ⊃ (O ∨ N)

3. 1. E ⊃ ~(F ⊃ G)
2. F ⊃ (E • H) / E ≡ F

4. 1. R ⊃ (S ∨ W)
2. R ⊃ (T ∨ W)
3. ~(W ∨ X) / R ⊃ (S • T)

5. 1. A ⊃ [(D ∨ B) ⊃ C] / A ⊃ (D ⊃ C)

6. 1. M ⊃ L
2. ~(K • N) ⊃ (M ∨ L) / K ∨ L

7. 1. A ⊃ B
2. ~C ⊃ ~(A ∨ ~D)
3. ~D ∨ (B • C) / A ⊃ (B • C)

8. 1. ~[J ∨ (F • ~H)]
2. ~G ⊃ ~H
3. G ∨ [~F ⊃ (J • K)] / E ∨ G

H) Predicate Logic – Translations ____

For each of the following passages, translate the text into monadic predicate logic, using the constants and predicates provided.

** each question in this section is worth 4 points **

1. Alan is not silly, but loves jokes and salad.
(a: Alan; Lx: x loves jokes; Sx: x loves salad)

Translation:

2. If Carla is absent minded, then Darlene is not absent minded, but is fair.
(c: Carla; d: Darlene; Ax: x is absent minded; Fx x is fair)

Translation:

3. If Eddie is not taking archery classes, then he does not get time off from work or he has lost interest in archery.
(e: Eddie; Ax: x takes archery classes; Wx: x gets time off from work; Lx – x has lost interest in archery)

Translation:

I) Predicate Logic – Derivations ____

These derivations *can* be completed using the rules of inference and/or equivalence and/or the methods of conditional proof and/or indirect proof, together with the following rules of predicate logic: Universal Instantiation (UI), Universal Generalization (UG), Existential Instantiation (EI), Existential Gneeralization

*****Note that there is a list of Universal Instantiation (UI), Universal Generalization (UG), Existential Instantiation (EI), Existential Gneeralization at the end of this exam*****

1. 1. (∀x)Ax ⊃ Ba

   2. (∀x) ~(Ax ⊃ Cx) / (∃x)Bx

2. 1. (∃x)(Dx • Fx)

   2. (∃x)(Gx ⊃ Ex)

   3. (∀x) ~(Hx ∨ Ex) / (∃x)Fx • (∃x) ~Gx

3. 1. (∀x)(Lx ⊃ ~Nx) • (∀x)(~Mx ⊃ ~Ox)

   2. (∀x) ~(~Nx • ~Ox) / (∀x)(Lx ⊃ Mx)

- **Modus ponens** (MP) is a rule of inference of **PL**, having the form
  $\alpha \supset \beta$
  $\alpha \quad / \beta$
- **Modus tollens** (MT) is a rule of inference of **PL**, having the form
  $\alpha \supset \beta$
  $\sim\beta \quad / \sim\alpha$
- **Disjunctive syllogism** (DS) is a rule of inference of **PL**, having the form
  $\alpha \vee \beta$
  $\sim\alpha \quad / \beta$.
- **Hypothetical syllogism** (HS) is a rule of inference of **PL**, having the form
  $\alpha \supset \beta$,
  $\beta \supset \gamma \quad / \alpha \supset \gamma$
- **Conjunction** (Conj) is a rule of inference of **PL**, having the form
  α
  $\beta \quad / \alpha \bullet \beta$
- **Addition** (Add) is a rule of inference of **PL**, having the form
  $\alpha \quad / \alpha \vee \beta$
- **Simplification** (Simp) is a rule of inference of **PL**, having the form
  $\alpha \bullet \beta \quad / \alpha$ or $\alpha \bullet \beta \quad / \beta$
- **Constructive dilemma** (CD) is a rule of inference of **PL**, having the form
  $\alpha \supset \beta$
  $\gamma \supset \delta$
  $\alpha \vee \gamma \quad / \beta \vee \delta$
- **De Morgan's** laws (DM) are rules of equivalence of **PL**, having the forms
  $\sim(\alpha \bullet \beta) \rightleftarrows \sim\alpha \vee \sim\beta$
  $\sim(\alpha \vee \beta) \rightleftarrows \sim\alpha \bullet \sim\beta$.
- **Association** (Assoc) are rules of equivalence of **PL**, having the forms
  $\alpha \vee (\beta \vee \gamma) \rightleftarrows (\alpha \vee \beta) \vee \gamma$
  $\alpha \bullet (\beta \bullet \gamma) \rightleftarrows (\alpha \bullet \beta) \bullet \gamma$
- **Distribution** (Dist) are rules of equivalence of **PL**, having the forms
  $\alpha \bullet (\beta \vee \gamma) \rightleftarrows (\alpha \bullet \beta) \vee (\alpha \bullet \gamma)$
  $\alpha \vee (\beta \bullet \gamma) \rightleftarrows (\alpha \vee \beta) \bullet (\alpha \vee \gamma)$.
- **Commutativity** (Com) are rules of equivalence of **PL**, having the forms
  $\alpha \vee \beta \rightleftarrows \beta \vee \alpha$
  $\alpha \bullet \beta \rightleftarrows \beta \bullet \alpha$
- **Contraposition** (Cont) is a rule of equivalence of **PL**, having the form
  $\alpha \supset \beta \rightleftarrows \sim\beta \supset \sim\alpha$
- **Material implication** (Impl) is a rule of equivalence of **PL**, having the form
  $\alpha \supset \beta \rightleftarrows \sim\alpha \vee \beta$
- **Material equivalence** (Equiv) are rules of equivalence of **PL**, having the forms
  $\alpha \equiv \beta \rightleftarrows (\alpha \supset \beta) \bullet (\beta \supset \alpha)$
  $\alpha \equiv \beta \rightleftarrows (\alpha \bullet \beta) \vee (\sim\alpha \bullet \sim\beta)$
- **Exportation** (Exp) is a rule of equivalence of **PL**, having the form
  $\alpha \supset (\beta \supset \gamma) \rightleftarrows (\alpha \bullet \beta) \supset \gamma$
- **Tautology** (Taut) are rules of equivalence of **PL**, having the forms
  $\alpha \rightleftarrows \alpha \bullet \alpha$
  $\alpha \rightleftarrows \alpha \vee \alpha$
- **Double negation** (DN) is a rule of equivalence of **PL**, having the form

$\alpha \rightleftarrows \sim\sim\alpha$

PREDICATE LOGIC

- **Universal instantiation** (UI), a rule of inference in predicate logic that allows for the removal of the universal quantifier when it is the main operator.
- For any variable α, any formula *F*, and any singular term β…

$$(\forall\alpha)F\,\alpha$$
$$F\,\beta$$

- **Universal generalization** (UG) is a rule of inference in predicate logic that allows for the addition of a universal quantifier.
- For any variable β, any variable α, and any formula *F* not containing α…

$$F\,\beta$$
$$(\forall\alpha)F\,\alpha$$

- **Existential instantiation** (EI) is a rule of inference in predicate logic that allows for the removal of the existential quantifier when it is the main operator.
- For any variable α, any formula *F* , and any *new* constant β…

$$(\exists\alpha)F\,\alpha$$
$$F\,\beta$$

  - A new constant is one that does not appear in either the premises or the desired conclusion.

- **Existential generalization** (EG) is a rule of inference in predicate logic that allows for the addition of an existential quantifier.
- For any singular term β, any variable α, and any formula *F* not containing α…

$$F\,\beta$$
$$(\exists\alpha)F\,\alpha$$