College of Science.
Department of Mathematics

كلية العلوم
قسم الرياضيات

**Second Midterm Exam**
**Academic Year 1445-1446 Hijri- Second Semester**

| Exam Information معلومات الامتحان | | | |
|---|---|---|---|
| Course name | Discrete Mathematics | | اسم المقرر |
| Course Code | Math 151 | | رمز المقرر |
| Exam Date | 2025-04-16 | 1446-10-18 | تاريخ الامتحان |
| Exam Time | 10: 00 AM | | وقت الامتحان |
| Exam Duration | 2 hours | ساعتان | مدة الامتحان |
| Classroom No. | | | رقم قاعة الاختبار |
| Instructor Name | د.جواهر المفرج | | اسم استاذ المقرر |

| Student Information معلومات الطالب | | |
|---|---|---|
| Student's Name | | اسم الطالب |
| ID number | | الرقم الجامعي |
| Section No. | | رقم الشعبة |
| Serial Number | | الرقم التسلسلي |

**General Instructions:**

- Your Exam consists of 6 PAGES (except this paper)
- Keep your mobile and smart watch out of the classroom.
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**تعليمات عامة:**

- عدد صفحات الامتحان [ ] صفحة. (بإستثناء هذه الورقة)
- يجب إبقاء الهواتف والساعات الذكية خارج قاعة الامتحان.
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**هذا الجزء خاص بأستاذ المادة**

***This section is ONLY for instructor***

| # | Course Learning Outcomes (CLOs) | Related Question (s) | Points | Final Score |
|---|---|---|---|---|
| 1 | C.LO.1.1 | Q1 | 8 | |
| 2 | C.L.O 1.2 | Q2 (A) | 4 | |
| 3 | C.L.O.2.2 | Q2(B) | 5 | |
| 4 | C.L.O.2.3 | Q3+Q4 | 4+2+2 | |
| 5 | | | | 25 |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |

EXAM COVER PAGE

| Questions | Q1 | Q2 | Q3 | Q4 | Total |
|---|---|---|---|---|---|
| Marks | | | | | |

**Question 1:** (8 points)

| Question Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Answer | | | | | | | | |

Choose the correct answer, then fill it in the above table:

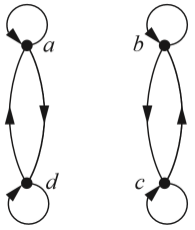
1) In the poset $(P(\mathbb{N}), \subseteq)$, the sets $\{1,2\}$ and $\{1,2,3\}$ are
   (a) Comparable.
   (b) Incomparable.

2) The relation $\{(a,b)|a+b \text{ is odd}\}$ on $\mathbb{Z}$ is a partial ordering.
   (a) True.
   (b) False.

3) Let $R = \{(a,b)|a \equiv b(mod3)\}$. Then
   (a) $[3] = [5]$ (b) $[1] = [3]$ (c) $[2] = [-1]$ (d) None.

4) If $R = \{(1,1),(1,2),(2,1),(2,2),(3,3),(4,4)\}$ is a relation on $\{1,2,3,4\}$ then the partition formed by this partition is:
   (a) $\{\{1,2\},\{3,4\}\}$
   (b) $\{\{1,2\},\{3\},\{4\}\}$
   (c) $\{\{1\},\{2\},\{3,4\}\}$
   (d) None.

5) The directed graph below represents a relation $R$ that is:




(a) Reflexive, symmetric, antisymmetric, and transitive.
(b) Reflexive, not symmetric, antisymmetric, and not transitive.
(c) Reflexive, not symmetric, not antisymmetric, but transitive.
(d) Reflexive, symmetric, not antisymmetric, and transitive.

6) The graph $K_{3,3}$ is considered
(a) 2-regular.
(b) 3-regular.
(c) 9-regular.
(d) None.

7) If $R = \{(a, b)|a \leq b\}$, is a relation on $\mathbb{R}$, then $R^{-1}$ equal
(a) $\{(a, b)|a < b\}$.
(b) $\{(a, b)|a > b\}$
(c) $\{(a, b)|a \geq b\}$
(d) None

8) If $R = \{(x, y)|y = \sqrt{x^2 + 1}\}$ and $S = \{(x, y)|y = \sqrt{x}\}$, where $R$ and $S$ defined on $\mathbb{R}^+$, then $R \circ S$ is defined as
(a) $\{(x, y)|y = \sqrt{\sqrt{x^2 + 1}}\}$.
(b) $\{(x, y)|y = \sqrt{x + 1}\}$
(c) $\{(x, y)|y = \sqrt{\sqrt{x} + 1}\}$
(d) None.

**Question 2:** (4+5 points)

(A) Let $R$ and $S$ be relations on $\{1,2,3\}$ and let $M_R = \begin{bmatrix} 1 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ and $M_S = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$ be the matrices of $R$ and $S$ respectively.

(1) List the ordered pairs of $R$ and $S$.

(2) Find $M_{R\cap S}$

(3) Find $M_{R\circ S}$

(4) Find $M_{\bar{R}}$

(5) Represent $S$ using directed graph.

(B) Let $R$ be the relation defined on $\mathbb{Z}$ by

$$aRb \Leftrightarrow 3a \equiv b(mod2)$$

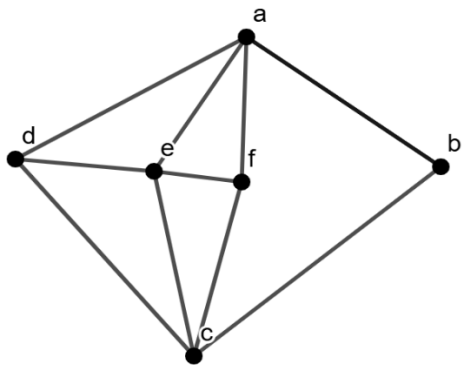
(1) Show that $R$ is an equivalence relation.

(2) Find [1] and [2]

(3) Is $[4] \cap [3] = \emptyset$? Justify your answer

**Question 3:** (4+2 points)

(A) Consider the graph $G$ below




(1) Find deg(a) and deg(d).

(2) Find $N(A)$ where $A = \{a,d\}$.

(3) Is the graph bipartite? Justify your answer.

(B) Let $A = \{1,2,3,6,8,9,12\}$. Draw the Hasse diagram representing the poset $\{(a,b)|a \text{ divides } b\}$ on $A$. Is the poset a totally ordered set? Justify your answer.

**Question 4:** (2 points)

For $K_{n,3}$ where $n > 3$, find the following:

(1) $|V|$

(2) Degree sequence of vertices in $K_{n,3}$

(3) $|E|$

(4) $|E|$ in $\overline{K_{n,3}}$

دعواتي لكن بالتوفيق