



(Knowledge for Development)

KIBABII UNIVERSITY
UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR
THIRD YEAR SECOND SEMESTER
MAIN EXAMINATION
FOR THE DEGREE OF BACHELOR OF EDUCATION AND
BACHELOR OF SCIENCE

COURSE CODE: MAP 323

COURSE TITLE: RING THEORY

DATE: 6/10/2021

TIME: 2:00 PM - 4:00 PM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of 3 Printed Pages. Please Turn Over.

QUESTION 1 (30 MARKS)

- a) Explain the meaning of the following terms as used in ring theory.
- i) Euclidean Domain
 - ii) Integral domain
 - iii) Principal Ideal Domain
 - iv) A Boolean ring (8 marks)
- b) Determine whether or not the following polynomials are irreducible over Z_5
- i) $f(x) = x^3 + 2x^2 - 3x + 4$ (6 mks)
 - ii) $g(x) = x^2 + 3x + 4$ (6 mks)
- c) Show that a Boolean ring \mathcal{B} , $x^2 = x$ for each $x \in \mathcal{B}$ implies $2x = 0$ (4 mks)
- d) Let x be a non zero element of a ring R with unity. Suppose there exists a unique $y \in R$ such that $xyz = x$, show that $xy = 1 = yx$. (6 mks)

QUESTION TWO (20 MARKS)

- a) Let A and B be ideals in R such that $B \subseteq A$. Show that $R/A \cong (R/B)/(A/B)$ (8 mks)
- b) Let R be a commutative ring with identity.

Show that if e is an idempotent element of R then $R \cong Re \oplus R(1 - e)$. (12 mks)

QUESTION THREE (20 MARKS)

- a) Let R be the ring of real numbers with unity, and let $R[x]$ be the polynomial ring over R . Let $J = (x^2 + 1)$ be the ideal in $R[x]$ consisting of the multiples of $x^2 + 1$. Show that the quotient $R[x]/J$ is the field of complex numbers. (12 mks)
- b) Find $q(r)$ and $r(x)$ in $Z_5[x]$ if $g(x) = 2x^3 + 3x^2 + 4x + 1$ is divided by $f(x) = 3x + 1$. (8 mks)

QUESTION FOUR (20 MARKS)

- a) Let $f: R \rightarrow S$ be a homomorphism of the ring R into a ring S . Show that the set $\{f(a) | a \in R\}$ is a subring of S (8 mks)
- b) Determine the idempotents, nilpotent elements and the units of the ring of integers modulo 10 (Z_{10}) (6 mks)
- c) Find the idempotents, nilpotent elements and the group of units of the ring of integers modulo 24 (Z_{24}) (6 mks)

QUESTION FIVE (20 MARKS)

- a) Show that the ring of Gaussian integers $R = \{m + n\sqrt{-1} \mid m, n \in \mathbb{Z}\}$ is a Euclidean ring if we set $\phi(m + n\sqrt{-1}) = m^2 + n^2$ (14 mks)
- b) Let R be a commutative ring with identity. Show that if e is an idempotent element of R , then $1 - e$ is also idempotent. (6 mks)