Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MAL3MA	Random process and Queueing theory	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW:

This course introduces learners to the applications of probability theory in the modelling and analysis of stochastic systems, covering important models of random processes such as Poisson Process, Markov chain and queueing systems. The tools and models introduced here have important applications in engineering and are indispensable tools in signal analysis, reliability theory, network queues and decision analysis

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Learning Level
CO 1	Interpret the phenomena which evolve probabilistically in time using the autocorrelation and power spectrum tools.	Understand
CO 2	Apply stationary stochastic processes and Poisson model in modelling random events	Apply
CO 3	Model random phenomena using discrete time Markov chains	Apply
CO 4	Apply the basic characteristic features of a queuing system and queuing models	Apply
CO 5	Apply basic principles of queueing theory in complex queueing systems	Apply

iii) SYLLABUS

Random processes and stationarity:Random processes-definition and classification, mean, autocorrelation, stationarity-strict sense and wide sense, properties of autocorrelation function of WSS processes. Power spectral density of WSS processes and its properties- relation to autocorrelation function. White noise.
Poisson processes: Ergodic processes-ergodic in the mean and autocorrelation. Mean ergodic theorems (without proof). Poisson processes-definition based on independent increments and stationarity, distribution of inter-arrival times, sum of independent Poisson processes, splitting of Poisson processes.
Markov chains: Discrete time Markov chain -Transition probability matrix, Chapman Kolmogorov theorem (without proof), computation of probability distribution, steady state probabilities. Classification of states of finite state chains , irreducible and ergodic chains.
Queueing theory-I: Queueing systems, Little's formula (without proof), Steady state probabilities for Poisson queue systems, M/M/1 queues with infinite capacity and finite capacity and their characteristics-expected number of customers in queue and system, average waiting time of a customer in the queue and system.
Queueing theory-II: Multiple server queue models, M/M/s queues with infinite capacity, M/M/s queues with finite capacity-in all cases steady state distributions and system characteristics-expected number of customers in queue and system, average waiting

time of a customer in the queue and system.

iv) a)TEXT BOOKS

1. Alberto leon Garciai, Probability and random processes for electrical engineering, Pearson Education, Third edition,2011.

2. V Sundarapandian, Probability statistics and queueing theory, Prentice-Hall Of India**,**2009.

b) **References**

1. T. Veerarajan, Probability and Statistics Random Process and Queueing Theory, Mc.Graw Hill Education, October 2018.

2. Moorthy MBK,Subramany K,Probability and Random Processess, Scitech Publications,Dec 2018.

(v) COURSE PLAN

Module	Contents	No. of hours
I	Random-process, classification, Mean, variance, autocorrelation, autocovariance Strict sense stationary processes WSS processes Properties of autocorrelation of a WSS process Power spectral density, relation to autocorrelation Delta function, white noise	9
II	Ergodic property, definition, examples Mean ergodic theorems and applications Poisson process-independent increments, stationarity Mean, variance, autocorrelation, autocovariance of Poisson process Distribution of inter-arrival times Splitting (thinning) of Poisson processes Merging of Poisson process	9
III	Discrete time Markov chain-memory lessness, examples Transiition probability matrix, Chapman-Kolmogorov Transition probabilities and transition matrices Chapman-Kolmogorov theorem and applications Computation of transient probabilities Computation of transient probabilities classification of states of finite-state chains, irreducible and ergodic chains Steady state probability distribution of ergodic chains	9
IV	Basic elements of Queueing systems, Little's formula, Steady state probabilities for Poisson queue systems M/M/1 queues with infinite capacity, steady state probabilities M/M/1 queues with infinite capacity-computating system characteristics M/M/1 queues with finite capacity, steady state probabilities M/M/1 queues with finite capacity-computating system characteristics	9
V	Basic elements of multiple server queues M/M/s queues with infinite capacity, steady state probabilities M/M/s queues with infinite capacity-computing system characteristics M/M/s queues with finite capacity, steady state probabilities M/M/s queues with finite capacity- computing system characteristics	9
	Total hours	45

(vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100marks**

(vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

(viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MAL3MB	Algebra and Number Theory	VAC	3	0	0	0	3	2023

i) COURSE OVERVIEW:

This is an introductory course in algebra and number theory with special emphasis on applications including RSA, prime factorization and the interplay between rings and numbers.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Learning Level
CO 1	Apply the concept and properties of natural numbers and division algorithm on number theoretic problems.	Apply
CO 2	Utilise the concepts and properties of prime numbers and basic factorisation algorithms in solving number theoretic problems	Apply
CO 3	Solve algebraic problems using the concepts and properties of groups and group structures	Apply
CO 4	Utilise the concept, properties and applications of cyclic groups, permutations and symmetric groups in algebraic problems	Apply
CO 5	Solve algebraic problems using the concept, properties and applications of rings and ring structures	Apply

iii) SYLLABUS

Elementary Number Theory: Division with remainder, congruences, greatest common divisor, Euclidean algorithm, Chinese remainder theorem, Euler's theorem

Prime Numbers: Prime Numbers- basic results, unique factorisation, computing Euler function, RSA explained, Fermat's little theorem, pseudoprimes, Algorithms for prime factorization Fermat's and Fermat-Kraitchik algorithms (evaluation only), Quadratic residues.

Introduction to Groups: Groups- Definition- basic properties and examples, subgroups and cosets, normal subgroups, group homomorphisms. Isomorphism theorem

Further topics in Group theory: Order of a group element, Cyclic groups, symmetric groups, cycles, simple transpositions and bubble sort, alternating groups.

Ring Theory: Rings- Definition, ideals, principal ideal domain, Quotient rings, Prime and maximal ideals, Ring homomorphisms, unique factorisation domain, irreducible and prime elements, Euclidean domain.

(iv) a) TEXT BOOKS

1. Niels Lauritzen, “Concrete Abstract Algebra”, Cambridge University Press,2003.

b) REFERENCES

1. David M Burton, “Elementary Number Theory”, 7th edition, McGraw Hill, 2011.
2. John B Fraleigh, “A first course in Abstract Algebra”. 7th edition, Pearson Education India, 2013
3. Joseph A Gallian, “Contemporary Abstract Algebra”, 9th edition, Cengage Learning India Pvt. Ltd. 2019.

(v) COURSE PLAN

Module	Contents	No. of hours
I	**Elementary Number Theory**-Division with remainder - Congruence- Properties of Congruence- Greatest Common divisor -Euclidean algorithm- Relatively prime numbers -Chinese Remainder Theorem- Euler’s Theorem	**9**
II	**Prime Numbers**- Basic Results- unique factorization- Computing φ−function- RSA explained- Fermat’s Little theorem, Pseudoprimes- Factorisation algorithms- Fermat’s algorithm- Fermat-Kraitchik algorithm- Quadratic residue- Quadratic residue applications	**9**
III	**Introduction to Groups**- DeSinition- Basic Properties- Examples- Subgroups- Cosets- Normal Subgroups- Quotient Groups- Group homomorphisms- Isomorphism theorem	**9**
IV	**Further topics in Group Theory**- Order of a group element- Cyclic Groups- Properties- Symmetric groups- Cycles- Properties- Simple transpositions- Bubble sort- Alternating groups	**9**
V	**Ring Theory**- Definition, basic properties, ideals- Quotient rings- Prime and Maximal ideals- Ring homomorphisms,- Unique factorization- Irreducible elements- prime elements- Euclidean domain	**9**
	Total hours	**45**

(vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100marks**

(vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

(viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours