Course Template (Syllabus)

Course Code / Course Name	SM211/Maths 3
Course Instructor Name(s)	Dr. Amit Chattopadhyay

Credits (L:T:P) **(Lecture : Tutorial : Practical)**	Select one from the following: (Place X appropriately)

Hours	Component
3	Lecture (1hr = 1 credit)
1	Tutorial (1hr = 1 credit)
0	Practical (2hrs = 1 credit)
4	**Total Credits=**

Grading Scheme *(Choose by placing X against appropriate box)*	*X*	4-point scale (A, A-, B+, B, B-, C+, C, D, F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(*Place X appropriately. More than one is okay)*

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

X	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Template Version	1.0
Template Date	April 2, 2021

Course Context and Overview

The aim of this course is to provide students with the foundations of probabilistic and statistical analysis used in varied applications in engineering and science. The first part of this course concentrates on the fundamentals of probability, event spaces, and random variables. Density and distribution functions for single and multivariate random variables, expectation, variance, and covariance, the binomial, uniform, poisson, exponential, and normal distributions, gamma beta, limit theorems. The second part of this course focuses on sampling distributions, understanding point and interval estimations of population parameters, hypothesis testing. Students will be given periodic problem sets which encourage them to think through concepts of the course.

Pre-Requisites (where applicable, specify exact course names)

Maths 1, Maths 2 and Maths 3 (understanding of Calculus and Linear Algebra)

Concept Map of the Course (Optional)

Course Outcomes and Competencies

Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the basic principles of probability theory for computing probabilities of events.	PO1, PSO4	U, Ap	C, P	3	1
CO2	Understand the definitions and properties of discrete and continuous random variables, probability distribution, probability density functions (p.d.f.) and some known distributions: Binomial, Poisson, Uniform, Normal, Beta1, Beta2, Gamma and Cauchy.	PO1, PSO4	U, Ap	C, P	6	2
CO3	Compute expectation, mean, moments, median, skewness, kurtosis, moment generating functions and characteristic functions of univariate distributions.	PO1, PSO4	Ap	C, P	6	2
CO4	Understand the concepts for two or multi-dimensional random variables and their distributions, conditional distributions, expectations, covariance, correlation coefficients and regression curves, mutual independence,	PO1, PSO4	U, Ap	C, P	6	2

	reproductive property and apply for solving problems.					
CO5	Compute distribution for a transformation of both single and bivariate random variables.	PO1, PSO4	Ap	C, P	3	1
CO6	Understand limit theorems for a sequence of random variables and apply them for solving problems.	PO1, PSO4	U, Ap	C, P	3	1
CO7	Estimate population parameters from sample data sets and use the sampling distributions to compute confidence intervals for these population parameters.	PO1, PSO4	Ap	C, P	6	2
CO8	Learn Basic concepts of hypothesis testing and perform hypothesis tests on population means, variances and proportions.	PO1, PSO4	U, Ap	C, P	6	2
CO9	Compute least square curve fitting for a bivariate sample	PO1, PSO4	Ap	C, P	3	1

** PO/PSO - Programme Outcome / Programme Specific Outcomes*
** CL - Cognitive Level*
** KC - Knowledge Category*

Course Content (List of Topics)

Probability:

- **The Concept of Probability:** Random Experiments, Events, Mutually Exclusive Events, Exhaustive Set of Events, Statistical Regularity, Classical and Frequency Definitions and Drawbacks.
  The Axiomatic Construction: Axiomatic Definition and Deductions, Conditional Probability, Multiplication Rule, Bayes' Theorem, Independence of Events, Pairwise and Mutual Independence.
  Compound or Joint Experiment: Independence of Random Experiments, Independent Trials, Bernoulli Trials, Binomial Law, Multinomial Law, Poisson Trials.

- **Probability Distributions-I:** Random Variables, Discrete Distribution-*p.m.f.*, Properties, Important Discrete Distributions; Continuous Distribution-*p.d.f.*, Properties, Important Continuous Distributions; Transformation of Continuous Random Variable.

- **Mathematical Expectation-I:** Expectation of a Continuous Function of a Single Random Variable. Properties: Mean, Variance, SD, Moments, Skewness, & Kurtosis of a Distribution; Moment Generating Function, Characteristic Function; Median, Quartiles and Mode.

- **Probability Distributions-II:** Multidimensional Random Variables, DFs, Marginal Distributions, Discrete and Continuous Random Variables in two dimensions, Conditional Distributions, Transformation of continuous random variables in two dimensions.

- **Mathematical Expectation-II:** Expectation of Two-dimensional Distributions, Moments, Covariance and Correlation Coefficients, Conditional Expectations-Regression Curves, Principle of Least Squares-Regression Lines, M.G.F., Joint Characteristic Functions, Reproductive Property.

- **Convergence of a Sequence of Random Variables and Limit Theorems:** Convergence in Probability and Convergence in Distribution, Tchebycheff's Inequality and Theorem, Bernoulli's Theorem, Law of Large Numbers. Asymptotically Normal Distribution, Limit Theorem for Characteristic Functions, Central Limit Theorem, DeMoivre Laplace Limit Theorem.

- **Some Important Continuous Distributions:** Chi-square Distribution, *t*-Distribution, *F*-Distribution and important statistics.

Statistics:

- **Random Samples:** Populations and samples; Distributions of the Sample; Sample Characteristics - Sample Mean, Sample Variance, Moments.
  Sampling Distributions: Sampling distributions of 'Statistics'; Estimates - Consistent and Unbiased, Important sampling distributions.

- **Estimation of Parameters:** MLE, Interval Estimates, Approximate Confidence Interval for the Mean of a Bernoulli Random Variable.

- **Testing of Hypothesis:** Introduction, Significance Levels, Tests Concerning the Mean of a Normal Population, Hypothesis Tests Concerning the Variance of a Normal Population, Hypothesis Tests in Bernoulli Populations, Tests concerning the Mean of a Poisson Distribution.

- **Regression:** Least square estimators of the Regression Parameters.

Instruction Schedule

Provide session-wise schedule

Learning Resources

Mention text books, reference books and other learning resources required as part of the course

1. Introduction to Probability and Statistics for Engineers and Scientists, Sheldon M. Ross, Fourth Edition.
2. Sheldon Ross, "A first course in Probability", Eighth Edition, Prentice Hall.

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Assessment Plan

List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)

Quiz1-20%, Midterm-25%, Quiz2-20%, Endterm-25%, Class participation-10%

Assignments / Projects

List exact number of assignments or projects included (provide generic description)

S. No.	Focus of Assignment / Project	CO Mapping

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Each of the two Quizzes will carry 20% weightage
- Midterm and Final Exams each will carry 25% weightage.
- Attendance and class-participation will carry 10% weightage.

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Not applicable

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[As per institute policy]

Citation Policy for Papers

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[As per institute policy]

Accommodation of Divyangs

State any special action taken to accommodate Divyangs

[As per institute policy]