COURSE NAME AND CODE: **INTRODUCTION TO PROBABILITY THEORY (MATH2404)**

LEVEL: II

SEMESTER: I

NUMBER OF CREDITS: 3

PREREQUISITES: (MATH1141, MATH1142, MATH1151 & MATH1152) or (M10A & M10B)

RATIONALE:
This course aims to give students a basic knowledge in the theory of probability and to prepare them for further courses in Statistics, Stochastic processes, and actuarial and financial mathematics. This will be of great value to students preparing for careers in financial services, biostatistics, engineering, and the design and management of complex systems.

COURSE DESCRIPTION:
This is a classical course in the theory of probability - the branch of mathematics that quantifies uncertainty. The course provides an initial review of concepts in elementary probability, before moving to a detailed exploration of the notions of density, distribution and moment. Various case study examples are used to show how these ideas can be used in solving real-world problems. Finally, asymptotic theory is presented, with an illustration of the use of the Weak Law of Large Numbers and the central limit theorem in sampling technique and approximation.

CONTENT:
Review of basic notions of probability-Discrete random variables-Continuous random variables-Asymptotic theory

LEARNING OBJECTIVES:
By the end of the course, students will be able to:

- calculate probabilities of simple events;
- classify a random variable according to the nature of the problem;
- draw plots of density and cumulative distribution functions of main discrete and continuous random variables;
- find moments of discrete and continuous random variables directly and with help of moment generating function;
- solve problem involving geometrical, uniform, Poisson, exponential, normal and gamma distributions;
- apply Chebyshev's inequality to prove the Law of Large Numbers;
- apply the Central Limit Theorem to statistical sampling;
- use the Central Limit Theorem to construct Normal approximations.

SYLLABUS:

Review of basic notions of probability:

- Notions of random phenomena, event, outcome, working definition of probability,
- Combinatorial techniques, permutations and combinations.
- Probability of intersection and union of events, mutually exclusive and exhaustive events, complimentary events. Conditional probability.
- Independence, the total probability rule, Bayes' theorem.

Discrete random variables:

- Probability density function, cumulative distribution function.
- Binomial, uniform, geometric, Poisson distributions.
- Multidimensional random variables, joint density, marginal density. Independence.
- Expectation, moments, variance and standard deviation.
- Covariance and correlation coefficient. Uncorrelated random variables.

Continuous random variables:

- Probability density function, probability distribution function.
- Uniform, Normal, exponential and gamma distributions.
- Expectation, moments, variance and standard deviation.
- Moment generating function.

Asymptotic theory:

- Chebishev's inequality. Weak Law of Large Numbers.
- Central Limit Theorem.
- Normal and Poisson approximations.

TEACHING METHODOLOGY:

Students will be exposed to the theoretical aspects of the theory of probability through informative lectures. Tutorials (provided as needed during scheduled lecture hours) will reinforce their learning and provide experience with the practical application of different type of problems.

The total estimated 39 contact hours may be accounted for as follows: 26 hours of lectures and 13 hours of tutorials. Course material, including practice problems, will be posted on the webpage

http://ourvle.mona.uwi.edu/

ASSESSMENT:

The course assessment has three components:

1. One 1 hour in-course test - 15%
2. Two assignments [7.5% each] - 15%
3. Final theory exam [2 hours]- 70%

REFERENCE MATERIAL:

Books

1. DEGROOT, Morris H. & Mark J. Schervish. *Probability and Statistics. 4th edition*. Addison-Wesley. 2011. ISBN-10: 0321500466 [prescribed]

2. ROSS, Sheldon M. *First Course in Probability (8th Edition)*, Academic Press, 2009. ISBN-10: 013603313X [recommended]

3. HASTINGS, Kevin J. *Probability and Statistics*. Addison-Wesley. Advanced Series in Statistics. 1997. ISBN: 0201592789 9780201592788 [recommended]

These books are pedagogically sound, comprehensively address all element of the syllabus, and provide useful case studies and examples.

Online Resources:

1. http://mathforum.org/library/topics/probability/
   The MathForum Internet Mathematics Library.

2. http://walrandpc.eecs.berkeley.edu/126notes.pdf
   Lecture Notes on Probability Theory and Random Processes by *Jean Walrand.*