Syrian Arab Republic

Higher Institute for Applied Sciences and Technology

Course Specification Document

Title	Random Processes and Queuing Theory

Credits	4.5 ECTS

Aims	This course aims to provide the student with knowledge of random signals and their temporal, statistical and frequency characteristics, forms of noise, types of random signals and their modeling and applications, with a focus on Markovian chains and their applications and the queuing theory and its models, enabling him to study subsequent engineering courses.

Intended learning outcomes

On successful completion of this course, the student will be able to:

- Understand the necessary basic concepts in probability and random processes for applications, such as random signals, linear systems in communication and control engineering.
- Understand the concept of stationary ergodicity process.
- Study various noise parameter estimations methods such Poisson, Gaussian, Random-walk, white noise
- Comprehend the homogeneous Markov chains with general (measurable) state space, and study of "sub-Markovian kernels" or "transition probabilities".
- Recognize the basic characteristic features of a queuing system and acquire skills in analyzing queuing models.
- Apply mathematical models using the computer to obtain operational models.

Syllabus

- **An introduction to the use of probability applications in engineering:** Utilizing the fundamentals of probability, conditional probability and Bayesian theory in communications and signal processing problems, reviewing distinctive and moment-generating functions.
- **Understanding random processes:** Mathematical study random processes representation, probability density function, cumulative distribution function, mean, variance, and auto-correlation function of random processes.
- **Studying the statistical and time properties of random processes:** Stability in broad and detailed senses, ergodic processes.
- **The relationship between random processes:** Independence in random processes, cross-correlation function and its coefficient.
- **Spectral representation of random processes:** Power spectral density and its calculation and

properties, cross-spectral density and its calculation and properties, forming and interpreting angular-frequency-weighted cross-spectral density, power spectral density for the sum of two processes and their products.

- **LTI system:** Input-output relationships, system response to a random input.
- **Famous models of random processes and noise:** Gaussian random processes, white, colored, correlated and uncorrelated noise, Wiener process and Wiener path, various definitions of Poisson process and its properties and applications, counting process, renewal process, events occurrence moments process, ARMA signals, cyclo-stationary random processes.
- **Queueing theory:** Definition and description of a queue, processes describing queue dynamics, Little's formula.
- **Study of some queueing patterns and their statistical properties:** M/M/1 pattern and M/M/s pattern, M/M/1/K pattern and M/M/s/K pattern.
- **Discrete-time Markov chains:** Definitions and representation of Markov chains, Chapman-Kolmogorov relation, transition probabilities, state and path probabilities, equilibrium state: conditions, calculation and properties, statistical properties of Markov states, applications of Markov chains.
- **Hidden Markov model:** What is a hidden Markov model and its mathematical relations, model construction, solution algorithms, introduction to machine learning.