# FST
# Computer and Information Science Department
# CISB456 – Queue and Scheduling
# Syllabus

## Part A – Course Outline

## Elective course in Computer and Information Science

## Catalog description:

(3) 3 credits. Queueing Theory Primer, including Markov chains, Birth-Death Processes, and Poisson Process; Simple Markovian Queueing models, and optimization processing. General scheduling problems and algorithms introduction.

## Prerequisites:

- SFTW 210, MATH 111

## Textbook(s) and other required material:

- Fundamentals of Queueing Theory
  --- (Fourth Edition) Donald Gross, John F. Shortle, James M. Thompson, and Carl M. Harris, WILEY
- Scheduling: Theory, algorithms, and Systems
  ---(Second Edition) Michael Pinedo, Pearson Education, Inc.

## References:

- 排隊論及其在現代通信中的應用 -- 盛友招 編著 人民郵電出版社

## Major prerequisites by topic:

1. Probability & Statistics
2. Algorithms and Data

## Course objectives*:

1. Introduce to students the general mathematical foundation and applications in queueing system. [a, e]
2. Introduce to students the different queueing models [a,e]
3. Introduce to students how to use models to analyze queueing phenomena and develop queueing solutions. [a,e,j,k]
4. Introduce to students the general scheduling problems and algorithms. [e,j,k]
5. Learning to apply course material to improve thinking, and problem solving. [k]

## Topics covered:

1. **Basic queueing problem and processes (2 hours):** Introduce the basic concepts, the typical queueing process patterns, applications, and notation used in the queueing system.
2. **Mathematical foundation in queueing theory (9 hours):** Study the general mathematical foundation related with the queueing system, including Poisson Prcoess, the Expoenetial Distribution, Markovian Property and Makov Chains, and Brith-Death Processes.
3. **Simple Markovian Queueing Models (12 hours):** Study the details of the simple Markovian birth-death queueing models, including different situations in Single-Server Queues (M/M/1, M/M/1/1, M/M/1/m, and M/M/1/m/m, etc.), and different situations in Multi-Server Queues (M/M/n, M/M/n/n, M/M/n/m, M/M/∞, M/M/n/m/m, M/M/n/n/m and M/M/n/n+m/m, etc.). Introduce the steady-state solutions for different models and applications in practice.
4. **Optimization queueing processing (1 hours):** Discuss how to estimate the parameters in the queueing models. The topics focus on the Cost Model and Expectation Model.
5. **Classification of scheduling problems (2 hours):** Introduce basic concepts used in scheduling, the role of scheduling, and the classification of the scheduling problems.
6. **Single and parallel machine models (deterministic) (12 hours) :** Study the details of the Deterministic Models, including the Single and Parallel machine models. The basic framework and notation in deterministic models are introduced. The

topics discussed in Single Machine Models cover The Total Weighted Completion Time, The maximum Lateness, The Number of Tardy Jobs, The Total Tardiness and The To Total Weighted Tardiness. The topics in Parallel Machine Models include The Makespan without Preemption, The Makespan with Preemptions, The Total Completion Time without Preemptions, The Total Completion Time with Preemptions, and Due Date-Related Objectives.

7. **Design, development, and implementation of scheduling systems (4 hours):** Introduce the scheduling problems in practice, including the Dispatching and Composite Dispatching Rules, Filtered Beam Search, Simulated Annealing and Tabu-Search, and Genetic Algorithm. The scheduling Systems Architecture, Databases and Knowledge-Bases, User Interfaces and Interactive Optimization, and Implementation and Maintenance Issues are also discussed.

## Class/laboratory schedule:

4 hour lectures, including three hours tutorials every three weeks. (14 weeks)

| Timetabled work in hours per week | | | No of teaching weeks | Total hours | Total credits | No/Duration of exam papers |
|---|---|---|---|---|---|---|
| Lecture | Tutorial | Practice | | | | |
| 3 | Nil | Nil | 14 | 42 | 4 | 2 hours |

## Student study effort required

| **Class contact** | |
|---|---|
| Lecture | 38 hours |
| In class practice | 4 hours |
| **Other study effort** | |
| Self-study | 20 hours |
| Assignments | 14 hours |
| class exercises | 4 hours |
| **Total student study effort** | 80 hours |

## Student assessment

Final assessment will be determined on the basis of
Assignments: 50%
Class exercises: 20%
Final examination: 30%

## Course assessment

The assessment of course objectives will be determined on the basis of

1. Assignments, class exercises, and exam
2. Course evaluation

## Course outline:

| **Weeks** | **Topic** | **Course work** |
|---|---|---|
| 1 | **Introduction to queueing problems**<br>The basic concepts, the typical queueing process patterns, applications, and notation used in the queueing system.<br>**Theoretical Foundations**<br>Poisson Prcoess, the Expoenetial Distribution | |
| 2,3 | **Mathematical Foundations**<br>Markovian Property and Makov Chains, Brith-Death Processes. | |
| 4 | **Mathematical Foundations** | Class exercise1 |

| | | |
|---|---|---|
| | Exercises.<br><br>**Single-Server Markovian Queueing Models**<br>Different situations in Single-Server Queues. | |
| 5,6 | **Single-Server Markovian Queueing Models (continued)**<br><br>**Multi-Server Markovian Queueing Models**<br>Different situations in Single-Server Queues | Assignment 1 |
| 7,8 | **Multi-Server Markovian Queueing Models (continued)**<br><br>**Optimization queueing processing**<br>Cost Model and Expectation Model | Assignment 2 |
| 9 | **Introduction to scheduling problems**<br>Basic concepts, the role of scheduling, and the classification of the scheduling problems.<br><br>**Single machine models (deterministic)**<br><br>Basic framework and notation | |
| 10,11 | **Single machine models (deterministic)**<br>The Total Weighted Completion Time, The maximum Lateness, The Number of Tardy Jobs, The Total Tardiness and The To Total Weighted Tardiness<br><br>**Parallel machine models (deterministic)**<br><br>The Makespan without Preemption | |
| 12,13 | **Parallel machine models (deterministic)**<br><br>The Makespan with Preemptions, The Total Completion Time without Preemptions, The Total Completion Time with Preemptions, and Due Date-Related Objectives.<br><br>**General purpose procedures for scheduling in practice**<br><br>Introduce the scheduling problems in practice, including the Dispatching and Composite Dispatching Rules, Filtered Beam Search, Simulated Annealing and Tabu-Search, and Genetic Algorithm. | Class exercise 2 |
| 14 | **Design, development, and implementation of scheduling systems**<br><br>The scheduling Systems Architecture, Databases and Knowledge-Bases, User Interfaces and Interactive Optimization, and Implementation and Maintenance Issues | Assignment 3 |

## Contribution of course to meet the professional component:

This course prepares students to work professionally in the area of computer and information science.

## Relationship to CIS program objectives and outcomes:

This course primarily contributes to Computer and Information Science program outcomes that develop student abilities to:

(a) an ability to apply knowledge of computing, mathematics, science, and engineering.

(e) an ability to analyze a problem, and identify, formulate and use the appropriate application requirements for obtaining its computing solution.

The course secondarily contributes to Computer and Information Science program outcomes that develop student abilities to:
(j) a knowledge of contemporary issues.
(k) an ability to use the techniques, skills, and modern computer tools necessary for engineering practice.

## Relationship to CS program criteria:

| Criterion | DS | PF | AL | AR | OS | NC | PL | HC | GV | IS | IM | SP | SE | CN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scale: 1 (highest) to 4 (lowest)** | 1 | | 2 | | 4 | | | | | | | | | 4 |

Discrete Structures (DS), Programming Fundamentals (PF), Algorithms and Complexity (AL), Architecture and Organization (AR), Operating Systems (OS), Net-Centric Computing (NC), Programming Languages (PL), Human-Computer Interaction (HC), Graphics and Visual Computing (GV), Intelligent Systems (IS), Information Management (IM), Social and Professional Issues (SP), Software Engineering (SE), Computational Science (CN).

## Course content distribution:

| **Percentage content for** | | | |
|---|---|---|---|
| Mathematics | Science and engineering subjects | Complementary electives | **Total** |
| 15% | 85% | 0% | 100% |

## Persons who prepared this description:

Liming Zhang, September 09, 2010.

# Part B General Course Information and Policies

Instructor: Dr. Liming Zhang
Office: B1 A410
Office Hour: W 2:30 – 5:30PM or by appointment
Phone: 8397 4560
Email: lmzhang@umac.mo

**Time/Venue:**

**Assessment:**
Final assessment will be determined on the basis of:
Homework 50 % Class exercises 20%
Final Exam (Comprehensive) 30%

**Grading Distribution:**

Percentage grade = (grade/the highest grade in class) X 100%

| Percentage Grade | Final Grade | | | | |
|---|---|---|---|---|---|
| 100 - 90 | A | 89 - 80 | B | | |
| 79 - 70 | C | 69 - 60 | D | below 59 | F |

**Comment:**
The objectives of the lectures are to explain and to supplement the text material. Students are responsible for the assigned material whether or not it is covered in the lecture. Students who wish to succeed in this course should work all homework and class exercises. Students are encouraged to look at other sources (other texts, etc.) to complement the lectures and text.

**Homework Policy:**
The completion and correction of homework is a powerful learning experience; therefore:

- There will be approximately 3 homework assignments.
- Homework is due two weeks after assignment unless otherwise noted, no late homework is accepted.
- Possible revision of homework grades may be discussed with the grader within one week from the return of the marked homework
- The course grade will be based on the average of the HW grades.

**Note**

- Class exercise sessions are important part of this course and attendance is strongly recommended.
- Check UMMoodle for announcement, homework and lectures. Report any mistake on your grades within one week after posting.
- No make-up exam is give except for CLEAR medical proof.
- No exam is given if you are 30 minutes late in the final exam. Even if you are late in the exam, you must turn in at the due time.
- Cheating is absolutely prohibited by the university.