

University of Macau
Faculty of Science and Technology
Department of Computer and Information Science
SFTW320 – Queue and Scheduling
Syllabus
1st Semester 2010/2011
Part A – Course Outline

Elective course in Computer Science

Course description:

4 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.

Course type

Theoretical with class exercises.

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:

- *Applications of Queueing Theory in Communication*
--- Shen Youzhao. Posts & Telecom Press, China

Major prerequisites by topic:

1. Probability & Statistics
2. Algorithms and Data Structure

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 algorithm. [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 (12 hours):** Study the general mathematical foundation related with the queueing system, including Poisson Process, the Exponential Distribution, Markovian Property and Markov Chains, and Birth-Death Processes.
3. **Simple Markovian Queueing Models (16 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 ($M/M/n$, $M/M/n/n$, $M/M/n/m$, $M/M/\infty$, $M/M/n/m/m$, $M/M/n/n/m$ and $M/M/n/n+m/m$, etc.). Introduce the steady-state solutions for different models and applications in practice.

4. **Optimization queueing processing (2 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) (16 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 (6 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				
4	Nil	Nil	14	56	4	2 hours

Student study effort required

Class contact	
Lecture	52 hours
In class practice	4 hours
Other study effort	
Self-study	26 hours
Assignments	14 hours
class exercises	4 hours
Total student study effort	100 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 The basic concepts, the typical queueing process patterns, applications, and notation	

	used in the queueing system. Theoretical Foundations Poisson Process, the Exponential Distribution	
2,3	Mathematical Foundations Markovian Property and Markov Chains, Birth-Death Processes.	
4, 5	Mathematical Foundations Exercises. Single-Server Markovian Queueing Models Different situations in Single-Server Queues.	Class exercise 1
6,7	Single-Server Markovian Queueing Models (continued) Multi-Server Markovian Queueing Models Different situations in Single-Server Queues	Assignment 1
8	Multi-Server Markovian Queueing Models (continued) Optimization queueing processing Cost Model and Expectation Model	Assignment 2
9	Introduction to scheduling problems Basic concepts, the role of scheduling, and the classification of the scheduling problems. Single machine models (deterministic) Basic framework and notation	
10,11	Single machine models (deterministic) The Total Weighted Completion Time, The maximum Lateness, The Number of Tardy Jobs, The Total Tardiness and The Total Weighted Tardiness Parallel machine models (deterministic) The Makespan without Preemption	
12,13	Parallel machine models (deterministic) The Makespan with Preemptions, The Total Completion Time without Preemptions, The Total Completion Time with Preemptions, and Due Date-Related Objectives. General purpose procedures for scheduling in practice 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 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 CS 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%

Coordinator:

Prof. Li Yiping

Persons who prepared this description:

Liming Zhang

Part B General Course Information and Policies

1st Semester 2010/2011

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: M 4:30 – 6:30pm, U106; Thurs 9:30-11:30, WLG 303;

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, late homework will be deducted 10% marks for each delayed day.
- 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.

Exams:

One 2-hour exam will be held during the semester. The exam is open book examinations. There will be in-class exercises.

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 given except for CLEAR medical proof.
- Cheating is absolutely prohibited by the university.

Appendix:

Rubric for Program Outcomes

Rubric for (a)	5 (Excellent)	3 (Average)	1 (Poor)
Understand the theoretic background	Students understand theoretic background and the limitations of the respective applications.	Students have some confusion on some background or do not understand theoretic background completely.	Students do not understand the background or do not study at all.
Use a correct model and formulation correctly	Students choose a model correctly and properly apply correct techniques.	Students choose a wrong model sometime, use a wrong formula, or a different technique.	Students use a wrong model and wrong formula, or do not know how to model.
Compute the problem correctly	Students use correct techniques, analyze the problems, and compute them correctly.	Students sometime solve problem mistakenly using wrong techniques.	Students do not know how to solve problems or use wrong techniques completely.
Rubric for (e)	5 (Excellent)	3 (Average)	1 (Poor)
Identify applications in engineering systems	Students understand problem and can identify fundamental formulation.	Students understand problem but cannot apply formulation, or cannot understand problem.	Students cannot identify correct terms for engineering applications.
Modeling, problem formulation and problem solving	Students choose and properly apply the correct techniques.	Students model correctly but cannot select proper technique or model incorrectly but solve correctly accordingly.	Students at loss as to how to solve a problem.
Rubric for (j)	5 (Excellent)	3 (Average)	1 (Poor)
Relevance to the present time	Student displays an understanding of the theoretical or practical impact and an ability to correlate a subject, perception, communication, association and reasoning from a global and societal perspective.	Student is able to display an understanding of current topics and issues with some knowledge regarding their impact in a bigger global and societal sense.	Student has difficulty demonstrating an awareness or familiarity with current topics and issues relevant to most current global and societal affairs.
Rubric for (k)	5 (Excellent)	3 (Average)	1 (Poor)
Use modern principles, skills, and tools in engineering practice	Student applies the principles, skills and tools to correctly model and analyze engineering problems, and understands the limitations.	Student applies the principles, skills and tools to analyze and implement engineering problems.	Student does not apply principles and tools correctly and/or does not correctly interpret the results.