SA402 – Dynamic and Stochastic Models — Fall 2016

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List of Course Standards

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		Relevant homework
Sample path analysis		
A1	**Sample path analysis.** I can simulate a simple system by hand (e.g. the Darker Image case). I can compute performance measures using sample paths resulting from simulation and interpret their meaning.	2.1, 4.8
Probability essentials		
B1	**Computing with probability distributions.** I can compute the probability that a random variable takes certain values based on its pmf/pdf or cdf. I can obtain the cdf of a random variable from its pmf/pdf and vice versa. I can compute the expected value and the variance of a random variable.	3.1, 3.2, 3.3ac, 3.5ab, 3.18abc, 3.19abc, 3.20abc
B2	**Interpreting probability distributions.** I can describe in words the basic properties of a random variable given its definition, pmf/pdf or cdf (e.g. discrete or continuous, minimum and maximum values, relative likelihood of values).	3.3b, 3.5c
B3	**Joint probabilities.** I can compute the probability that one or more random variables take certain values, given a joint probability distribution. I can interpret the meaning of these probabilities.	3.8, 3.9
B4	**Conditional probabilities.** I can compute conditional probabilities using a joint probability distribution. I can compute probabilities using the law of total probability. I can interpret the meaning of these probabilities.	3.6, 3.8, 3.9, 3.31
B5	**Independence.** I can explain in words why two random variables are independent or not independent.	3.9a
Modeling stochastic processes algorithmically		
C1	**Random variate generation.** I can find a random variate generator for a discrete or continuous random variable. I can explain in words how it can be used to generate random variates.	3.17abc
C2	**Constructing and interpreting stochastic process models.** I can construct and interpret stochastic process models using the algorithmic framework for simple systems.	4.4, 4.6
Poisson arrival processes		
D1	**Computing arrival probabilities for stationary Poisson processes.** I can compute probabilities involving the number of arrivals in a given time interval and the time of the nth arrival for a stationary Poisson process.	5.1, 5.3abcd, 5.5, 5.6, 5.14 (also see problems for D3)

		Relevant homework
D2	**Computing expected arrival values for stationary Poisson processes.** I can compute the expected number of arrivals in a given time interval and the expected time of the nth arrival for a stationary Poisson process.	5.3bc (also see problems for D3)
D3	**Decomposition and superposition.** I can recognize and apply the decomposition and superposition of Poisson processes.	5.3ef, 5.10, 5.12, 5.13, 5.15, 5.17bcd
D4	**Integrated rate functions.** I can compute the integrated rate function of a nonstationary Poisson process given its arrival rate function. I can explain its meaning in words.	5.20a
D5	**Computing arrival probabilities for nonstationary Poisson processes.** I can compute probabilities involving the number of arrivals in a given time interval and the time of the nth arrival for a nonstationary Poisson process.	5.20bcde
D6	**Properties of Poisson processes.** I can describe in words the fundamental properties of stationary and nonstationary Poisson processes (e.g. independent increments, stationary increments, memorylessness). I can explain why these properties may or may not be satisfied in a given situation.	5.8, 5.15, 5.17a
Markov chains		
E1	**Transition matrices and diagrams.** I can construct and interpret the one-step transition matrix and transition probability diagram of a Markov chain.	6.2, 6.4ac, 6.5
E2	**Finite-step probabilities.** I can compute the probability that a Markov chain is in a particular state after a finite number of steps (i.e. n-step transition probabilities, n-step state probabilities, and first-passage probabilities). I can interpret the meaning of these probabilities. I can use these probabilities to compute related performance measures.	6.4b, 6.17b, 6.18
E3	**Irreducible sets, transient and recurrent states.** I can identify irreducible sets of states of a Markov chain, and explain why. I can classify states of a Markov chain as transient or recurrent, and explain why.	6.5, 6.6, 6.17c
E4	**Steady-state probabilities.** I can compute the probability that a Markov chain is in a particular state in the long-run, including absorption probabilities. I can interpret the meaning of these probabilities. I can use these probabilities to compute related performance measures.	6.8, 6.11, 6.20b, 6.21bc
E5	**Modeling with Markov chains.** I can identify when a Markov chain is an appropriate model for a system and construct such a model.	6.17a, 6.20a, 6.21a
E6	**Properties of Markov chains.** I can describe in words the fundamental properties of a Markov chain (i.e. the Markov property, time stationarity). I can explain why they may or may not be satisfied in a given situation.	Justify why the properties of a Markov chain are satisfied in 6.17a, 6.20a, 6.21a

		Relevant homework
Markov processes and queueing systems		
F1	**Generator matrices and transition rate diagrams.** I can construct and interpret the generator matrix and the transition rate diagram of a Markov process.	Write the generator matrix and transition rate diagram for 7.10
F2	**Steady-state probabilities of a Markov process.** I can compute the probability that a Markov process is in a particular state in the long-run. I can interpret the meaning of these probabilities. I can use these probabilities to compute related performance measures.	7.10
F3	**Modeling with birth-death processes.** I can identify when a birth-death process is an appropriate model for a system and construct such model. This includes modeling phenomena such as balking, queue capacity, and reneging.	8.6a, 8.10e, 8.11a, write the model for 8.4, 8.8d
F4	**Steady-state probabilities of a birth-death process.** I can compute the steady-state probability of the number of customers in the system of a birth-death process. I can interpret the meaning of these probabilities.	See problems for F5
F5	**Performance measures for birth-death processes.** I can compute and interpret system-level and customer-level performance measures of a birth-death process using steady-state probabilities and Little's law. System-level measures include: expected number of customers in the system/queue, traffic intensity, expected number of busy servers. Customer-level measures include: effective arrival rate, expected waiting time, expected delay.	8.4abc, 8.6bcd, 8.10f, 8.11bcd
F6	**Classifying standard queueing models.** I can recognize and classify queueing systems using the standard queueing shorthand notation.	Determine appropriate standard queueing models for 8.5, 8.8, 8.10a
F7	**Performance measures for basic standard queueing models.** I can compute and interpret steady-state probabilities and performance measures for $M/M/s$, $M/M/\infty$, and $G/G/s$ queueing systems.	8.5ab, 8.8abc, 8.10bcd
Technical communication: writing a review of a research article		
G1	**Understanding the stochastic process model and assumptions.** I can describe how the article's authors model the real-world system they are studying as a stochastic process. I can describe the assumptions they make about the system, and discuss whether these assumptions are reasonable.	Project
G2	**Understanding the analysis of the stochastic process model.** I can describe the insights and conclusions that the article's authors draw from studying their model. I can offer meaningful suggestions on how the authors' model can be improved.	Project
G3	**Technical writing.** I can write a review that is clear, concise, and well-organized.	Project