CSC412/2506 Final Exam Topics to Focus Study

The exam will cover lecture content from week 1 to week 11.
During the exam you are permitted a non-programmable calculator and one double-sided, handwritten $8.5'' \times 11''$ aid sheet.

To focus your study, consider in particular the following topics:

- Details for the main distributions we considered in class (e.g. Bernoulli, Categorical, Univariate and Multivariate Gaussian). Computational complexity for evaluating their density. Number of parameters. Kinds of data they describe. Their conjugate priors.
- Probability Fundamentals. Definitions of expectation and variance. Manipulate expectations as integrals.
- Exponential Family models. Understand the different terms in the canonical representation. Be able to manipulate the canonical representation to identify parameters and sufficient statistics for examples of exponential family models.
- Basic Classifiers. Probabilistic formulation of models (e.g. regression, clustering) from joint density. Understand fundamental operations. Maximum likelihood on basic models. Maximum Likelihood vs Maximum a Posteriori.
- Graphical Models. Know differences between directed and undirected graphical models, especially evaluating conditional probability statements (e.g. Bayes' Ball). Semantics for conditional independence in graphs (e.g. Markov Blanket, Global Markov Property). Representing directed graphs as undirected and vice versa (moralization, triangulation). Cliques, maximal cliques and their relationship with factors / potentials.
- Exact Inference. Bayes' theorem. Variable elimination algorithm. Elimination ordering and its relationship to computational complexity. Variable elimination as graph transformation and induced graph. Sum Product belief propagation algorithm.
- Variational Inference. Forward vs Reverse KL-Divergence. Deriving the Evidence Lower Bound (ELBO).

- Sampling. Simple Monte Carlo. ~~Bias and variance~~ of a Monte Carlo estimator. Algorithm, properties, and weaknesses of sampling methods from lecture (Rejection, Metropolis-Hastings, Importance)
- Sequential Models. Hidden Markov Model. Understand parameterization of HMM (Initial Distribution, Transition, Emission). Dependences in n-th order Markov Models.
- Stochastic Variational Inference. Simple Monte Carlo for unbiased gradient estimation (score function vs pathwise derivative estimators). Reparameterization Trick. SVI algorithm for learning latent variable models. Variational vs Monte Carlo methods.