Statistics and Actuarial Science

For students admitted in or before September 2019:
- 2 compulsory courses (SSAF6001 & STAT6003) & 3 elective courses

For students admitted in September 2020 and thereafter:
- 5 compulsory courses & 1 elective course from the list below

### Departmental Coursework Requirement 2020-21
(For RPG students enrolled in September 2020 - August 2021)

<table>
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<th>Course Code</th>
<th>Course Title</th>
<th>Compulsory (C)/Elective (E)</th>
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<tr>
<td>SSAF6001 *</td>
<td>Basic Laboratory Safety Course for RPg Candidate in the Faculty of Science</td>
<td>C</td>
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<td>STAT6003</td>
<td>Research Postgraduate Seminar</td>
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<td>STAT6008</td>
<td>Advanced Statistical Inference</td>
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<td>STAT6009</td>
<td>Research Methods in Statistics</td>
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<td>STAT6019</td>
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**Students are required to choose 1 course from the following in the first semester:**

- STAT6005 Special Studies in Statistics
- STAT6010 Advanced Probability
- STAT6011 Computational Statistics

* Starting from the academic year 2010-11, SSAF6001 "Basic Laboratory Safety Course for RPg Candidates in Faculty of Science" will be made compulsory to students with the following registration dates (MPhil candidates registered on or after January 1, 2009), (3-year PhD candidates registered on or after January 1, 2008) & (4-year PhD candidates registered on or after January 1, 2007).

### Departmental Course Details 2020-21

The passing mark for the departmental courses (STAT6XXX) taken by RPG is **55**.

The following courses are mainly designed for RPG students with strong statistical background. Students without sufficient statistical trainings (e.g., non-statistical majors) are advised to consult with the course instructors before registration.

#### STAT6003 Research postgraduate seminar (COMPULSORY)
(only offered to RPG in Department of Statistics & Actuarial Science)

#### STAT6005 Special studies in statistics

The aim of the course is to introduce students to the topics which are of relevance to their research study but have not been taken previously. Students will be instructed to attend one course or a combination of courses from the department as prescribed by the supervisor(s) and approved by the Chairman of the Departmental Research Postgraduate Committee. Alternately this course may consist of supervised reading supplemented by written work and prescribed coursework.

Students are permitted to replace this course by another RPG course from the MPhil/PhD curricula offered by other Departments, subject to the approval of the Departmental Research Postgraduate Committee.

**Assessment: to be determined.**
STAT6008 Advanced statistical inference (COMPULSORY)
This course covers the advanced theory of point estimation, interval estimation and hypothesis testing. Using a mathematically-oriented approach, the course provides a formal treatment of inferential problems, statistical methodologies and their underlying theory. It is suitable in particular for students intending to further their studies or to develop a career in statistical research. Contents include: (1) Decision problem – frequentist approach: loss function; risk; decision rule; admissibility; minimaxity; unbiasedness; Bayes’ rule; (2) Decision problem – Bayesian approach: prior and posterior distributions, Bayesian inference; (3) Estimation theory: exponential families; likelihood; sufficiency; minimal sufficiency; completeness; UMVU estimators; information inequality; large-sample theory of maximum likelihood estimation; (4) Hypothesis testing: uniformly most powerful (UMP) test; monotone likelihood ratio; UMP unbiased test; conditional test; large-sample theory of likelihood ratio; confidence set; (5) Nonparametric inference: bootstrap methods.
Assessment: One 2-hour written examination; 40% coursework, 60% examination.

STAT6009 Research methods in statistics (COMPULSORY)
This course includes two modules.
The first module, Asymptotic Statistics, introduces some fundamental tools in asymptotic statistics which potential graduate students will find useful in preparing for work on a research degree in statistics. Focus is on applications of state-of-the-art statistical techniques and their underlying theory. Contents may be selected from: 1) Modes of stochastic convergence; 2) Limit theorems; 3) Stochastic orders and the delta method; 4) Order statistics and sample quantiles; 5) M-estimator, Z-estimator and the maximum likelihood estimator; 6) Non-parametric estimation of distributions; 7) U-statistics and projection estimators; 8) Other topics as determined by the instructor.
The second module, High-dimensional Statistics, introduces some fundamental tools in high-dimensional statistics. Focus is on applications of state-of-the-art statistical techniques and their underlying theory. Contents may be selected from: 1) Curse of the dimension; 2) Estimation of high-dimensional means; 3) Estimation of high-dimensional covariance matrix; 4) High-dimensional PCA; 5) High-dimensional regression; 6) High-dimensional factor models; 7) Compressed sensing; 8) Other topics as determined by the instructor.
Assessment: One 2-hour written examination; 25% coursework, 75% examination.

STAT6010 Advanced probability
This course provides an introduction to measure theory and probability. The course will focus on some basic concepts in theoretical probability which are important for students to do research in actuarial science, probability and statistics. Contents include: sigma-algebra, measurable space, measure and probability, measure space and probability space, measurable functions, random variables, integration theory, characteristic functions, convergence of random variables, conditional expectations, martingales.
Assessment: one 2-hour written examination; 25% coursework, 75% examination.

STAT6011 Computational statistics
This course aims to give postgraduate students in statistics a background in modern computationally intensive methods in statistics. It emphasizes the role of computation as a fundamental tool of discovery in data analysis, of statistical inference, and for development of statistical theory and methods. Contents include: Bayesian statistics, Markov chain Monte Carlo methods including Gibbs sampler, the Metropolis-Hastings algorithm, and data augmentation; Generation of random variables including the inversion methods, rejection sampling, the sampling/importance resampling method; Optimization techniques including Newton’s method, expectation-maximization (EM) algorithm and its variants, and minorization-maximization (MM) algorithms; Integration including Laplace approximations, Gaussian quadrature, the importance sampling method; and other topics such as Hidden Markov models, neural networks, and Bootstrap methods.
Assessment: One 2-hour written examination; 50% coursework, 50% examination.

STAT6019 Current Topics in Statistics (COMPULSORY)
This course includes two modules.
The first module, Causal Inference, is an introduction to key concepts and methods for causal inference. Contents include 1) the counterfactual outcome, randomized experiment, observational study; 2) Effect modification, mediation and interaction; 3) Causal graphs; 4) Confounding, selection bias, measurement error and random variability; 5) Inverse probability weighting and the marginal structural models; 6) Outcome regression and the propensity score; 7) The standardization and the parametric g-formula; 8) G-estimation and the structural nested model; 9) Instrumental variable method; 10) Machine learning methods for causal inference; 11) Other topics as determined by the instructor.
The second module, Posterior Inference and Simulation, cover topics from: 1) Large-sample properties of posterior distribution; 2) Langevin dynamics and Hamiltonian MCMC; 3) Sequential Monte Carlo methods; 4) Approximation Bayesian computation; 5) Variational Bayesian methods; 6) Other topics as determined by the instructor.
Assessment: One 2-hour written examination; 25% coursework, 75% examination.