Mathematical statistics **(M347)** content listing

Block 1 *Review and distribution theory*	
Unit 1 *Starting points*	Revision of basic statistical and mathematical ideas that are assumed prerequisites from earlier study.
Unit 2 *Univariate continuous distribution theory*	Pdfs, cdfs, moments, moment generating functions; the quantile function, median, quartiles, probability integral transformation; chi-squared, *t*, *F*, gamma and beta distributions.
Unit 3 *Multivariate continuous distribution theory*	Bivariate joint densities and distribution functions, marginal and conditional distributions, independence, Bayes theorem; bivariate moments and conditional moments; covariance and correlation; bivariate normal distribution; extension to the general multivariate case; multivariate normal distribution.
Block 2 *Classical inference*	
Unit 4 *Basic ideas of statistical inference*	Point estimation, confidence intervals, hypothesis testing, quantiles, the likelihood, maximum likelihood estimation.
Unit 5 *Point estimation*	General ideas of maximum likelihood estimation; properties of estimators, unbiased estimators, Cramér-Rao lower bound, efficiency, consistency, sufficiency; properties of maximum likelihood estimators.
Unit 6 *Hypothesis tests and confidence intervals*	Size and power, Neyman-Pearson lemma, generalised likelihood ratio test, Wald and score tests; random intervals, pivotal quantities, likelihood ratio and Wald confidence intervals.
Unit 7 *Asymptotic theory*	Convergence in probability, mean square and distribution, Markov and Chebyshev inequalities; law of large numbers, central limit theorem; asymptotic likelihood theory, score and information functions, asymptotic normality, unbiasedness and efficiency of maximum likelihood estimators in regular cases, with examples of non-regular cases.
Block 3 *Bayesian statistics*	
Unit 8 *Prior to posterior*	Basic ideas, calculating posteriors; conjugate models in binomial, Poisson, normal cases, conjugacy and the natural exponential family.
Unit 9 *Bayesian inference*	Loss functions; point estimation, interval estimation, highest posterior density intervals; nuisance parameters; predictive inference; Bayes factors; likelihood and sufficiency.
Unit 10 *Markov chain Monte Carlo*	Stochastic simulation, Monte Carlo error; Markov chains, equilibrium distributions, reversible Markov chains; basic ideas of MCMC, Metropolis-Hastings algorithm, choice of proposal density, Gibbs sampling; dealing with MCMC samples.
Block 4 *Linear modelling*	
Unit 11 *Linear regression*	The model for one explanatory variable, maximum likelihood estimators, sampling distributions of MLEs, distribution of residuals, prediction intervals; the Bayesian approach, priors, joint posterior, marginal posteriors, credible intervals, prediction.
Unit 12 *Multiple regression*	Matrix notation, MLEs, the hat matrix, RSS; Sampling distributions; partitioning sums of squares; the analysis of variance table.
Unit 13 *General and generalised linear models*	The general linear model, Gauss-Markov theorem; generalised linear models, the exponential dispersion family, linear predictors, link functions, inference, deviance.
Unit 14 *Bayesian modelling*	Linear regression with conjugate and non-conjugate priors, generalised linear models.