Discipline Specific Elective (DSE) Course 2e: Computational Techniques

Course Title and Code	Credits	Credit Distribution of Course			Eligibility Criteria	Prerequisite of the course (if any)
		Lecture (30 Hours)	Tutorial (00 Hours)	Practical (60 Hours)		
DSE 1a: Computational Techniques	4	2	0	2	NIL	NIL

Course Objectives:

- To learn the advanced techniques of modelling real data from diverse discipline.

Course Learning Outcomes: After successful completion of this course, the students will be able to:

- Simulate statistical models.
- Understand linear models and distinguish between fixed, random and mixed effects models.
- Learn and apply regression technique in their area of study.
- Understand and apply time series models.

Unit I (7 Hours)

Probability Distributions: Bernoulli, Binomial, Poisson, Multinomial, Uniform, Exponential, Gamma, Beta, Normal, Chi Square, t and F distribution. Simulation: Random number generation, simulating statistical models, Monte Carlo Methods.

Unit II (8 Hours)

Linear Models: Fixed, random and mixed effects models, ANOVA: one way and two-way, ANOCOVA. Regression Models: Simple and Multiple Linear Regression, Forward, Backward and stepwise regression, Residual analysis. Diagnostics and tests for violations of model assumptions: Multicollinearity, Autocorrelation and Homoscedasticity.

Unit III (7 Hours)

Generalized Linear Model: Exponential family of distributions, Link function, Canonical link Function, deviance, Logit and Probit models, Logistic and Poisson regression. Lack of fit tests.

Unit IV (8 Hours)

Time Series: Stationary and Nonstationary time series, Autocorrelation and Auto-covariance functions and their properties, Tests for trend and seasonality. Stationary processes: Moving average (MA) process, Auto-regressive (AR) process, ARMA, ARIMA and SARIMA models. Estimation of mean, auto-covariance and auto-correlation function under large sample theory, forecasting.

Note: Data analysis and applications of the methods are to be carried out using a statistical package like Excel/R/SPSS/MINITAB/MATLAB or any other.

Essential Readings:

1. Agresti, A. (2015). *Foundations of Linear and Generalized Linear Models,* John Wiley & Sons.
2. Chatterjee, S. and Hadi, A.S. (2012). *Regression Analysis by Example,* John Wiley & Sons.
3. Johnson, N.L., Kotz, S. and Balakrishnan, N. (2000). *Discrete Univariate Distributions,* John Wiley & Sons.
4. Johnson, N.L., Kotz, S. and Balakrishnan, N. (2000). *Continuous Univariate Distributions,* John Wiley & Sons.
5. Montgomery, D.C. (2001). *Designs and Analysis of Experiments*, John Wiley & Sons.
6. Montgomery, D.C., Jennings, C.L. and Kulahci, M. (2008). *Introduction to Time Series Analysis and Forecasting,* John Wiley & Sons.
7. Ross, S.M. (2006). *Simulation,* American Press.

Suggested Readings:

1. Cryer, J.D. and Chan, K. (2008). *Time Series Analysis: With Applications in R,* Springer.
2. Fox, J. and Weisberg, S. (2011). *An R Companion to Applied Regression,* Sage.
3. Kroese, D.P. and Chan, J.C.C. (2014). *Statistical Modeling and Computation,* Springer.
8. Voss, J. (2014). *An Introduction to Statistical Computing,* John Wiley & Sons.
9. Weisberg, S. (2014). *Applied Linear Regression,* John Wiley & Sons.

List of Practicals:

1. Fitting of Probability distributions.
2. Random number generation
3. Problem based on one way ANOVA and Two-way ANOVA
4. Problem based on ANOCOVA

5. Fitting of Linear Regression, Forward, Backward and stepwise regression.
6. Logistic and Poisson regression. Lack of fit tests.
7. Time Series: Tests for trend and seasonality.
8. Fitting and forecasting of various time series processes: MA, AR, ARMA, ARIMA, SARIMA.