Syllabus template

Semester: 2	
Course : Economics	
Paper Title: MATHEMATICAL METHODS IN ECONOMICS–II	
Paper code: C1EC230221T	**Credits: 4**
Hours/week : 4	
Category: Core/MDC/SEC/VAC : Core	
Theory / Practical / Composite : Theory	
No of Modules : 2	

Course Overview:

1. To study how matrices organise and manipulate data, and to apply matrix operations effectively in solving economic problems.
2. To study the concepts of vector spaces, eigenvalues, and quadratic forms, and to analyse their relevance in multivariate optimisation and economic dynamics.
3. To study higher-order derivatives to analyse concavity, convexity, quasi-concavity, and quasi-convexity on $\mathbb{R}^n$, and to apply these ideas in determining stationary and extreme values of multivariable functions.
4. To study techniques for handling constrained optimisation problems involving functional relationships, and to apply the method of Lagrange multipliers in maximisation and minimisation contexts.
5. To study the value function and the envelope theorem, and to evaluate how these tools can be used in economic applications.
6. To study first- and second-order differential equations and to apply appropriate solution techniques to relevant economic problems.

Course Outcome:

Module 1:

1. **Identify** fundamental concepts of linear algebra, including vector spaces, subspaces, bases, scalar products, norms, orthogonality, linear transformations, systems of linear equations, and determinants.
2. **Describe** geometric representations of multivariable functions—such as graphs and level curves—and explain differentiability, Jacobians, Hessians, homogeneity, and homotheticity.
3. **Apply** multivariable calculus and linear algebra techniques to compute Jacobians and Hessians, implement the implicit function theorem, and solve linear systems relevant to economic analysis.
4. **Analyze** convex, concave, quasiconvex, and quasiconcave functions, examine their geometric properties, and differentiate conditions for local and global optimization.
5. **Evaluate** methods of unconstrained and constrained optimization, justify the use of Lagrange multipliers, and assess optimization outcomes using value functions and the envelope theorem.
6. **Construct** multivariable optimization frameworks by integrating linear algebra, calculus, and constrained optimization tools to develop original economic problem-solving models.

Module 2:

1. **Recognize** different types of first-order and second-order differential equations and the basic elements involved in their formulation.				
2. **Summarize** the key concepts, solution forms, and interpretation of first-order and second-order differential equations in meaningful terms.				
3. **Implement** standard techniques to solve first-order and second-order differential equations relevant to economic and applied problem contexts.				
4. **Differentiate** between various methods of solving differential equations and examine how solution behavior changes under different conditions.				
5. **Justify** the choice of specific solution approaches by assessing their effectiveness and appropriateness for particular applied problems.				
6. **Develop** original applied models using first-order and second-order differential equations to represent dynamic processes in economics or related fields.				
Prerequisites: MATHEMATICAL METHODS IN ECONOMICS–I				
SYLLABUS				
UNIT/Module	**CONTENT**	**HOURS or NUMBER OF CLASSES**	**CO Mapping**	**COGNITIVE LEVEL**
I.	1. Linear algebra Vector spaces: Sub-space and basis, algebraic and geometric properties, scalar products, norms, orthogonality; linear transformations: properties, matrix representations and elementary operations; systems of linear equations: properties of their solution sets; determinants: characterization, properties and applications. 2. Functions of several variables: Geometric representations: graphs and level curves; differentiable functions: characterizations, properties with respect to various operations and applications; second order derivatives: Jacobian and Hessian determinants, properties and applications; the implicit function theorem, and application to comparative statics problems; homogeneous and homothetic functions: characterizations and applications. 3. Multi-variable optimization: Convex sets: geometric properties of functions: convex concave functions, their characterizations, properties and	3 classes per week	CO1, CO2, CO3, CO4, CO5, CO6	K1,K2, K3, K4, K5, K6

	applications; further geometric properties of functions: quasiconvex and quasiconcave functions, their characterizations, properties and applications; unconstrained optimization: geometric characterizations, characterizations using calculus and applications; constrained optimization with equality constraints: geometric characterizations, Lagrange's method; value function, envelope theorem.			
II.	Differential Equations: First & Second Order with Applications	1 class per week	CO1, CO2, CO3, CO4, CO5, CO6	K1,K2, K3, K4, K5, K6

Text Books

1. K.Sydsaeter and Hammond,MathematicsforEconomicAnalysis, Pearson Educational Asia: Delhi,2002.
2. Lawrence Blume and Carl Simon, Mathematics for Economists, W.W. Norton and Company, 1994
3. Alpha Chiang and Kevin Wainwright, Fundamental Methods of Mathematical Economics, Fourth Edition, Mc-graw Hill, 2005.

Suggested readings

1. A. Mukherjee and S.Guha, Mathematical Methods & Economic Theory, Oxford University Press, 2011.K.G. Binmore, Mathematical Analysis, Cambridge University Press, 1991.
2. G. Hadley, Linear Algebra, Addison Wesley

Web Resources

NA

Evaluation :CIA: 30 (20+5+5)+ End Semester:70

Paper Structure for Theory Semester Exam:

Module	**No. of questions to be answered**	**No. of alternatives given**	**Marks**
Module 1 (35 marks)	3	4	3×5=15
	4	5	4×10=40
Module 2 (35 marks)	1	2	1×5=5
	1	2	1×10=10
		Total	**70**

Course outcomes (COs) and Cognitive Level Mapping

COs	**CO Description**	**Cognitive levels**
	Module 1	
CO1	Identify fundamental concepts of linear algebra, including vector spaces, subspaces, bases, scalar products, norms,	K1

	orthogonality, linear transformations, systems of linear equations, and determinants.	
CO2	Describe geometric representations of multivariable functions—such as graphs and level curves—and explain differentiability, Jacobians, Hessians, homogeneity, and homotheticity.	K2
CO3	Apply multivariable calculus and linear algebra techniques to compute Jacobians and Hessians, implement the implicit function theorem, and solve linear systems relevant to economic analysis.	K3
CO4	Analyze **c**onvex, concave, quasiconvex, and quasiconcave functions, examine their geometric properties, and differentiate conditions for local and global optimization.	K4
CO5	Evaluate methods of unconstrained and constrained optimization, justify the use of Lagrange multipliers, and assess optimization outcomes using value functions and the envelope theorem.	K5
CO6	Construct multivariable optimization frameworks by integrating linear algebra, calculus, and constrained optimization tools to develop original economic problem-solving models.	K6
	Module 2	
CO1	Recognize different types of first-order and second-order differential equations and the basic elements involved in their formulation.	K1
CO2	Summarize the key concepts, solution forms, and interpretation of first-order and second-order differential equations in meaningful terms.	K2
CO3	Implement standard techniques to solve first-order and second-order differential equations relevant to economic and applied problem contexts.	K3
CO4	Differentiate between various methods of solving differential equations and examine how solution behavior changes under different conditions.	K4
CO5	Justify the choice of specific solution approaches by assessing their effectiveness and appropriateness for particular applied problems.	K5
CO6	Develop original applied models using first-order and second-order differential equations to represent dynamic processes in economics or related fields.	K6