Course Title: Fundamental Calculus

Course No.: Math Ed 439 (Minor) Full mark: 100

Nature of Course: Theoretical Pass mark: 35

Level: B.Ed. Total Period : 150

Year: Third Period per week : 6 Time per period: 55 minutes

**1. Course description**

This course is a first and friendly introduction to calculus, suitable for someone who has never seen the subject before, or for someone who has seen some calculus but wants to review the concepts and practice applying those concepts to solve problems. There are two different fields of calculus. The first subfield is called differential calculus. Using the concept of function and derivatives, it studies the behavior and rate on how different quantities change. Using the process of differentiation, the graph of a function can actually be computed, analyzed, and predicted. The second subfield is called integral calculus. Integration is actually the reverse process of differentiation, concerned with the concept of the anti-derivative. Using the process of integration, it evaluates the area, volume and arc length of the given curve. This introductory calculus course covers differentiation and integration of functions of one variable, with applications and differentiation of function of two and three variables. Topics on this course include function and graph, limit and continuity, differentiation, successive differentiation, partial derivative, application of derivative and furthermore, indefinite integrals, definite integrals and application of definite integrals.

**2. General objective**

After completing this course, students should demonstrate competency in the following skills:

* To define the function and sketch the graph of simple function.
* To evaluate the limit of functions and check the continuity of the function at given point.
* To interpret the geometrical and physical meaning of derivative and evaluate the nth derivative of functions.
* To use differentiation to solve related rates problems.
* To use differentiation to solve applied max/min problems and sketch the graph of a function by using first and second derivative
* To understand the function of two and three variables and evaluate these function’s derivatives.
* To evaluate integrals by using Riemann sums.
* To evaluate integrals using advanced techniques of integration, such as partial fractions and integration by parts.
* To apply integration to compute arc lengths, volumes and areas of curves.

**3. Specific objectives and contents**

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| **Specific objectives** | **Contents** |
| * Define cartesian product, relation, domain and range of a relation, inverse relation with examples. * Define function with examples * Explain the type of functions (injective, surjective and bijective ) * Define the composite function with examples * Define the special type of   functions with its graph  (identity, constant, absolute,  Algebraic, Linear and  quadratic ) with its graph | **Unit I**: **Functions and graphs 13**   * 1. Cartesian product , relation domain and range of a relation, inverse relation.   2. Function, type of function   (injective , surjective and bijective ) composite function.  **1.3:** Function of special type  (identity, constant, absolute),  algebraic function (Linear  and quadratic), exponential  and logarithmic function  1.4: The graph of the functions  mentioned in 1.3. |
| * Define Limit and it’s existence. * Define indeterminate form. * Express the algebraic properties of limit (without proof), * Prove the limit of function       ,     * Evaluate the limit of these above type’s functions. * Define the continuity of a function and check the continuity of the function at given points. * Define discontinuity and its type. | **Unit II: Limits and continuity (16)**  **2.1.** Limit and its existence,  indeterminate form.  **2.2** algebraic properties of  limit (without proof)  **2.3**. limit of function  ,  **2.4**. Continuity of a function, discontinuity and its type. |
| * Define derivative * List the Rule of differentiation * Evaluate derivative of algebraic trigonometric , exponential and logarithmic functions * Evaluate derivative of parametric and implicit functions. | **Unit III Differentiation (20)**  **3.1.** Definition of derivative  and its geometrical  meaning  **3.2**. Rule of differentiation  **3.3.** Derivative of algebraic  trigonometric, exponential  and logarithmic functions.  **3.4**. Evaluate derivative of parametric and implicit functions. |
| * Evaluate the second order derivative * Evaluate the higher order derivative of function (up to fifth order) * Successive differentiation of special functions (y=xn, y=(ax+b)n, y=eax+b, y=ln(ax+b), y=sin (ax+b) and y=cos(ax+b) ) * State and prove Leibnitz theorem. * Define power series, * Find the Taylor’s and Maclaurin series of given function (ex, ln(1+x), sinx, cosx ). | **Unit IV: Successive differentiation**  **(13)**  4.1. Second order derivative  4.2. higher order derivative  4.3. successive differentiation of special functions.  4.4. Leibnitz theorem  4.5. power series, Taylor’s and Maclaurin series. |
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| * Define function of two and three variables with examples * Define first and second order partial derivative * Define homogeneous functions * State Euler’s theorem and verify on homogeneous functions. | **Unit V: Partial Derivative (13)**  5.1. Function of two and three variables.  5.2. first and second order partial  derivative  5.3. Euler’s theorem on homogeneous  functions. |
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| * Define Increasing and decreasing functions. * State the necessary and sufficient condition for the Extreme value. * Explain the method to find the maxima and minima of function by first derivative test * Define concavity and point of inflection. * Explain the method to find the maxima and minima of function by second derivative test * Explain the method to find the absolute maxima and minima of functions. * Applied optimization problems (examples on mathematics, business and economics) * Explain derivative as a rate of change (examples on mathematics, business and economics). * Using first and second derivative sketch the graph of functions (cubic, biquadratic curve and of type | **Unit VI: Application of erivative (20)**  6.1. Increasing and decreasing functions.  6.2 Necessary and sufficient Condition for the Extreme value.  6.3. Maxima and minima of function  by first derivative test  6.4. Concavity and point of inflection.  6.5. Maxima and minima of function by second derivative test   * 1. Absolute maxima and minima of   functions.  6.7. Derivative as a rate of change  6.8. Sketching of the given curve |
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| * Define Indefinite integral * List the standard integral (algebraic, trigonometric, exponential and logarithmic ) * The techniques of integration (integration by substitution method, integration by by parts method, integration of rational functions). | **Unit VII: Indefinite integral (20)**  7.1. Indefinite integral  7.2. Integration by  substitution method  7.3 Integration by by-parts method  7.4. Integration of rational functions. |
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| * Define definite integrals. * Make definite integral by taking the limits on unit IX and evaluate it. * Explain geometric interpretation of * Prove the definite integral as the limit of sum * List the properties of definite integral and use it to evaluate the definite integral. | **Unit VIII: Definite integral**  (15)  8.1 Evaluate of definite integral  8.2. Geometric interpretation of  8.3 Definite integral as the limit of sum.  8.4. properties of definite integral and use it to evaluate the definite integral |
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| * Use the definite integral to find the area of plane region * Use the definite integral to find length of plane curve * Use the definite integral to find volume of solid of revolution * Define ordinary differential equation (first order and first degree) and find its solution.. | **Unit IX: Application of definite integrals (20)**  9.1 Definite integral as area under the given curve.  9.2. Definite integral as arc length of given curve.  9.3 Volume of solid of Revolution.  9.4. Ordinary differential equation (first order and first degree) and its solution. |
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**4. Instructional Techniques**

Nature of this course is theoretical so teacher - centered instructional techniques is used.

**4.1 General Instructional Strategies**

Because of the theoretical nature of the course, teacher-centered instructional techniques will be dominant in the teaching-learning process. The teacher will adopt the following techniques:

* Lecture with discussion
* Use of software (math lab, mathematical if possible)
* Investigative approach in problem solving

**4.2 Specific Instructional Strategies**

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| **Unit** | **Chapter** | **Instructional techniques** |
| I | Function and Graphs | Expository, Discussion and presentation |
| II | Limits and continuity | Expository, Discussion and presentation |
| III | Differentiation | Expository, Discussion and presentation |
| IV | Successive Differentiation | Project work, Presentation |
| V | Partial derivative | Expository, Discussion and presentation |
| VI | Application of derivatives | Project work, Home assignment |
| VII | Indefinite Integral | Class work, project work and assignment |
| VIII | Definite Integral | Class work, project work and assignment |
| IX | Application of Integrals | Class work, project work and assignment |

**5. Evaluations**

Students will be evaluated on the basis of the written classroom test in between and at the end of the academic session, the classroom participation, presentation of the reports and other practical activities. The scores obtained will be used only for feedback purposes. The Office of the Controller of the Examinations will conduct the annual examination at the end of the academic session to evaluate the student` performance. The types, numbers and marks of the subjective and objective questions will be as follows:

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| **Types of questions** | **Total questions to be asked** | **Number of questions to be answered and marks allocated** | **Total marks** |
| Group A: Multiple choice items | 20 questions | 20 × 1 marks | 20 |
| Group B: Short answers questions | 8 with 3 ‘or’ questions | 8 × 7 marks | 56 |
| Group C: Long answers questions | 2 with 1 ‘or’ questions | 2 × 12 marks | 24 |

**6. Recommended Books and References**

**6.1 Recommended books**

Fenny, King D. Charles and Ramesh M.R.(2012): *Calculus: Differentiation and*

*Integration,* ICFAI University press, Pearson publication.

Weir, Maurice D, Hass Joel & Giordano (2011): *Thomas’ Calculus*, Pearson

publication.

**6.2 Reference books**

B.C Das and B. N. Mukhaerjee (1975): *Differential Calculus*., U,N Dhur publication,

B.C Das and B. N. Mukharjee (1966): *Differential* *Calculus*., U,N Dhur publication,

Gilbert String : *Calculus*, Wellesley – Cambridge press.

S.K. Chung (2007: )*Understanding* *Basic* *Calculus*, University of Hong Kong