COURSE OUTLINE

Subject: AP Calculus BC

Unit: (1) Functional Analysis

The learner will:

- Represent functions numerically, graphically, algebraically and verbally.
- Classify and graph the elementary functions: power, root, polynomial, rational, algebraic, and transcendental (exponential, logarithmic, trigonometric and inverse trigonometric).
- Transform functions by shifting, stretching and reflecting.
- Analyze the differences in graphs $f(x)$, $f(|x|)$, and $|f(x)|$
- Define inverse functions and form function compositions.
- Analyze and graph planar curves including those given in parametric form, polar form and vector form.

Unit: (2) Limits and Continuity

The learner will:

- Calculate limits using algebra.
- Estimate limits from graphs or tables of data.
- Determine asymptotic behavior graphically and by using infinite limits analysis.
- Compare both relative magnitudes of functions and their rates of change.
- Determine the continuity of a function at a point.
- Apply graphical interpretations of continuity as in the Intermediate Value Theorem and the Extreme Value Theorem.

Unit: (3) Differentiation

The learner will:

- Define the derivative as a limit of the difference quotient.
- Interpret the derivative as an instantaneous rate of change.
- Relate the concepts of differentiability and continuity.
- Find the slope of a curve at a point and use it to write an equation of a tangent line if one exists.
- Use the tangent line as a linear approximation and graphically extend the concept of differentiability to local linearity.
- Approximate rate of change from graphs and data.
- Connect concepts of average vs. instantaneous rates of change and interpret verbally.
- Use differentiation rules for sums, products, quotients and compositions involving the elementary functions (power, exponential, logarithmic, trigonometric and inverse trigonometric) of single variable calculus.
- Differentiate implicitly defined functions.
- Differentiate parametric, polar and vector functions.

Unit: (4) Applications of Differentiation

The learner will:

- Use $f'(x)$ and $f''(x)$ to analyze both the local and global behavior of the graph of $f(x)$, including characteristics such as monotonicity, concavity, extrema and points of inflection.
- Find corresponding relationships among the graphs of $f(x)$, $f'(x)$, and $f''(x)$.
- Use the Mean Value Theorem and know its geometric consequences.
- Optimize, finding both absolute and relative extrema.
- Model rates of change, including related rates.
- Use the derivative in the study of motion: speed, velocity and acceleration for both elementary functions and for planar curves which are given in parametric, polar or vector form.

Unit: (5) Integration

The learner will:

- Compute Riemann sums using left, right and midpoint evaluation points.
- Investigate upper and lower Riemann sums.
- Recognize the definite integral as a limit of Riemann sums over equal subdivisions.
- Interpret the definite integral of the rate of change of a quantity over an interval as the change of the quantity over the interval.
- Use basic properties of definite integrals.
- Understand the basic premise of the Fundamental Theorem of Calculus, that is, integration is antidifferentiation.
- Use the Fundamental Theorem of Calculus to evaluate definite integrals.
- Connect both the concept of accumulation and the analytical features of the Fundamental Theorem of Calculus in interpreting the graphs of integral functions.
- Find antiderivatives analytically including a substitution of variables technique including change of limits for definite integrals.
- Use Riemann and trapezoidal sums to approximate definite integrals of functions represented algebraically, geometrically and by tables of values.
- Antidifferentiate using integration by parts and partial fractions techniques.

Unit: (6) Applications of Integration

The learner will:

- Use integrals to model physical, social or economic situations.
- Compute the area of a region.
- Compute volumes of solids of revolution and volumes of solids with known cross sections.
- Compute the distance traveled by a particle along a line.
- Determine the average value of a function over an interval and understand the geometric interpretation of average value.
- Use the integral of a rate of change to give accumulated change.
- Use data and Riemann summing to approximate definite integrals.
- Compute arc length (function or parametric).
- Compute polar area.

Unit: (7) Differential Equations

The learner will:

- Write equations involving derivatives from verbal descriptions (and vice versa).
- Find specific antiderivatives using boundary conditions.
- Solve separable differential equations and use them in modeling, such as exponential growth.

- Interpret differential equations geometrically via slope fields.
- Numerically approximate solutions to differential equations using Euler's Method.
- Solve logistic differential equations and use them in modeling.

<u>Unit: (8) Series and Polynomial Approximations</u>

The learner will:

- Compute limits using L'Hospital's Rule.
- Evaluate improper integrals (as limits of definite integrals).
- Define a series as a sequence of partial sums.
- Review geometric series and applications and the harmonic series.
- Determine convergence or divergence of a series of constants using the Integral Test, p-Series Test, Ratio Test, Comparison Tests and the Alternating Series Test.
- Interpret terms of a series as areas of rectangles and their relationship to improper integrals.
- Determine error bound in the sum of an alternating series.
- Write Taylor and Maclaurin Series for functions.
- Understand and use graphical convergence of the Taylor and Maclaurin series.
- Manipulate Taylor Series and use substitution, differentiation and antidifferentiation techniques to form new series from old series.
- Find the radius and interval of convergence of power series.
- Find the LaGrange error bound for Taylor polynomials.