University of Kerala

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|---|---|---|---|---|---|
| Discipline | Mathematics | | | | |
| Course Code | UK2DSCMAT108 | | | | |
| Course Title | Integral Calculus and Series | | | | |
| Type of Course | DSC | | | | |
| Semester | II | | | | |
| Academic Level | 100-199 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical | Total Hours per week |
| | 4 | 3 | - | 2 | 5 |
| Pre-requisites | Differential Calculus | | | | |
| Course Summary | The course deals with Integrals, applications of integrals and the fundamental theorem of calculus. The intuitive idea of Infinite series and Taylor's theorem is also explained. | | | | |

# Detailed Syllabus

| Module | Unit | Contents | Hrs |
|---|---|---|---|
| **I** | **Integration** | | **9** |
| | 1 | The Indefinite Integral: Antiderivatives, The Indefinite Integrals, Integration formulas, Properties of the indefinite integral, Integral curves. | |
| | 2 | Integration by substitution (excluding Integration using computer algebra systems) | |
| | 3 | Evaluation of definite integral by substitution | |
| | 4 | Integrals of logarithmic Functions | |
| | 5 | Integrals of exponential functions | |
| | Chapter 4: Section 4.2, 4.3, 4.9 chapter 6: section 6.2(integration only), 6.3(integration only) of Text[1] | | |

| Module | Unit | Contents | Hrs |
|---|---|---|---|
| **II** | **Applications of Integration** | | **9** |
| | 6 | Area between two curves | |
| | 7 | Volume by Slicing: (excluding other axis of revolution) | |
| | 8 | Length of a plane curve(excluding finding arc length by numerical methods) | |
| **III** | **Infinite series** | | **9** |
| | 9 | Sequences, Monotone sequences, Infinite series, Convergence tests, Comparison, ratio test | |
| | Chapter 9: Section 9.1, 9.2, 9.3, 9.4, 9.5 of Text [1] | | |
| **IV** | **Taylors theorem** | | **9** |
| | 10 | Maclaurin and Taylor polynomials and series, Power series (except functions defined by power series), Convergence of Taylor series | |
| | Chapter 9: Section 9.7, 9.8, 9.10 of Text [1] | | |
| **V** | **Suggestions for teacher designed module** | | **9** |
| | For internal assessment examinations only. | | |
| | 11 | An overview of area problem<br>Volume by other axis of revolution<br>Area of a surface of revolution<br>Alternating series<br>Absolute and conditional convergence<br>Root test<br>Convergence of Taylor series<br>Differentiating and integrating power series | |
| | These topics can be found on Chapter 4: Section 4.1, Chapter 5: Sections 5.2. 5.5, Chapter 9: Sections 9.6, 9.7, 9.8 of Text [1] | | |

# Topics for Practical sessions – 30 hours

1. Introducing the SAGEMATH interface, SAGE cell server; basic arithmetic involving operators $+, -, /$, exponentiation; functions like `sin, cos, tan,e,log, sqrt`, constant $\pi$
   Ref: P1, or section 2.3 of P2

2. Defining and using lists, dictionaries, sets, and accessing elements in lists and dictionaries
   Ref: section 5.1, 5.3, 5.4 of P3

3. Defining variables using `var`, defining polynomials, polynomial functions, evaluating them Ref: P3 or section 1.4 of P4

4. Using `integrate` command to compute indefinite and definite integrals
   Ref : Section 3.3.4 of P2

5. Sketching graphs of curves using `plot`
   Ref : Section 6.1 of P2

6. Find area of surface of revolution of curves
7. Find length of a plane curve
8. Defining curves, finding area between two curves
   Ref : Section 6.1 of P4
9. Finding volumes of solids of revolution, finding arc length
   Ref : Section 6.3 of P4
10. `diff` command to find derivatives of standard functions, polynomials, including higher order derivatives
    Ref: Section 3.1 of P4
11. Finding Taylor series representation of a function using differentiation (without usitng `taylor` function)
12. Finding McClaurin series representation of a function using differentiation
13. Finding Taylor series representation of a function using differentiation using `taylor` function
14. Plot the graph of the function, and its Taylor series approximation

**Problems for the practical examination**

1. Computing indefinite and definite integrals of standard functions (trigonometric, log, e, polynomials)
2. Demonstrate the plot command with various options (line style, color, thickness etc)
3. Finding area between two curves, sketching them
4. Find area of surface of revolution of curves
5. Find length of a plane curve
6. Finding volumes of solids of revolution, sketching the curves and solids
7. Defining various functions and finding derivatives of various orders
8. Finding Taylor series representation of a function using differentiation (without usitng `taylor` function)
9. Finding Taylor series representation of a function using differentiation using `taylor` function, and plot the graph of the function, and its Taylor series approximation
   Ref : Section 3.3 of P2
10. Finding McClaurin series representation of a function using differentiation

A record should be maintained with atleast 7 problems from the above. Each problem in the record must have a description of the problem, algorithm (step by step procedure), commands used, input given and output obtained accordingly. For the ESE, from the list of above 10 problems, the student should be able to answer two selected (from the 7 available in the record) by the examiner.

# Textbook


1. Howard Anton, Irel Bivens, Stephens Davis, *Calculus* $10^{th}$ Edition Wiley, 2012.


# References


1. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Publishers, $10^{\text{th}}$ Edition, 2018.

2. Joel Hass, Maurice D. Weir, *Thomas' Calculus Early Transcendentals*, $12^{\text{th}}$ Edition, Addison-Weseley Publishing Company, 2004

3. J Stewart, *Calculus with Early Transcendental Functions*, $7^{\text{th}}$ Edition, Cengage India Private Limited, 2008

4. G B Thomas, R L Finney, *Calculus*, $9^{\text{th}}$ Edition, Addison-Weseley Publishing Company, 2004.


# Resources for practical sessions

P1. Sagemath documentation – Introductory Sage Tutorial https://doc.sagemath.org/html/en/prep/Intro-Tutorial.html

P2. Saskia Roos, Michael Jung, *An Introductory Course on Sage, Lecture Notes* https://www.math.uni-potsdam.de/fileadmin/user_upload/An_Introductory_Course_on_Sage.pdf

P3. Sagemath documentation – Symbolic variableshttps://doc.sagemath.org/html/en/reference/calculus/sage/calculus/var.html

P4. Tuan A. Le, Hieu D. Nguyen, SageMath Advice for calculus https://users.rowan.edu/~nguyen/sage/SageMathAdviceforCalculus.pdf

P5. Sagemath documentation – Sage Quickstart for Multivariable Calculus https://doc.sagemath.org/html/en/prep/Quickstarts/Multivariable-Calculus.html

P6. Sagemath documentation – Parametric plots https://doc.sagemath.org/html/en/reference/plot3d/sage/plot/plot3d/parametric_plot3d.html#sage.plot.plot3d.parametric_plot3d.parametric_plot3d

P7. P. Zimmermann *et al*, Computational Mathematics with SageMath, https://www.sagemath.org/sagebook/english.html

P8. Gregory V. Bard, Sage for Undergraduates http://www.people.vcu.edu/~clarson/bard-sage-for-undergraduates-2014.pdf

P9. SageMath documentation – 3D Graphics https://doc.sagemath.org/html/en/reference/plot3d/index.html

# Course Outcomes

| CO No. | Upon completion of the course the graduate will be able to | PO/PSO | Cognitive Level | Knowledge Category | Lecture(L) Tutorial (T) | Assignment (As) |
|---|---|---|---|---|---|---|
| CO 1 | Understands the basic concept of Integrals and fundamental theorem of Calculus | PSO1, 2, PO1 | U | F,C | L,T | |
| CO 2 | Realise the concept of area between two curves | PSO2, PO3, 4 | R, U | F | L,T | |
| CO 3 | Develop a concrete idea about sequences and series | PSO1,3, PO2, 3 | U,An | C | L,T | |
| CO 4 | Use convergence tests to find limits | PSO3, PO3 | Ap | C,P | T | As |
| CO 5 | Apply integration in Modeling Taylor series | PSO1,3, PO3 | Ap | C,P | T | As |

**(R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create)**
**(F-Factual, C-Conceptual, P-Procedural, M-Metacognitive)**

# Mapping of CO with PSOs and POs

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | | | | | 3 | | | | | | | |
| CO2 | | 2 | | | | | | | 1 | 3 | | | | |
| CO3 | 2 | | 3 | | | | | 2 | 2 | | | | | |
| CO4 | | | 2 | | | | | 3 | | | | | | |
| CO5 | 2 | | 1 | | | | | 3 | | | | | | |

**( - -Nill, 1-Slightly/Low, 2-Moderate/Medium, 3-Substantial/High)**

## Assessment Rubrics

- Quiz/Assignment/Discussion/Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

## Mapping of COs to Assessment Rubrics

| | Internal Examination | Assignment | Project Evaluation | End Semester Exam |
|---|---|---|---|---|
| CO1 | ✓ | ✓ | | ✓ |
| CO2 | ✓ | | | ✓ |
| CO3 | ✓ | ✓ | | ✓ |
| CO4 | ✓ | | | ✓ |