COURSE OUTLINE OF RECORD

Number: MATH A290H **TITLE:** Introduction to Tensors and Calculus on Manifolds Honors

ORIGINATOR: Tab Livingston
EFF TERM: Fall 2015
FORMERLY KNOWN AS:
DATE OF OUTLINE/REVIEW: 03-04-2016
CROSS LISTED COURSE:
TOP NO: 1701.00
CID:

SEMESTER UNITS: 5.0
HRS LEC: 90.0 **HRS LAB:** 0.0 **HRS OTHER:** 0.0
CONTACT HRS TOTAL: 90.0
STUDY/NON-CONTACT HRS RECOMMENDED: 180.0
CATALOG DESCRIPTION:

Introductory study of elementary tensor algebra and calculus, differential and integral calculus in higher dimensions, differential forms, and calculus on manifolds. May be taken for grades or on a pass-no pass basis. Transfer Credit: CSU; UC.

JUSTIFICATION FOR COURSE:

Comparable to lower division UC course.

PREREQUISITES:

- MATH A280: Calculus 3 with a minimum grade of C or better
  or
- MATH A280H: Calculus 3 Honors with a minimum grade of C or better
  and
- MATH A285: Introduction to Linear Algebra and Differential Equations with a minimum grade of C or better
  or
- MATH A285H: Introduction to Linear Algebra and Differential Equations Honors with a minimum grade of C or better

COREQUISITES:
ADVISORIES:
ASSIGNED DISCIPLINES:
Mathematics
MATERIAL FEE: Yes [ ] No [X] Amount: $0.00
CREDIT STATUS: Noncredit [ ] Credit - Degree Applicable [X] Credit - Not Degree Applicable [ ]
GRADING POLICY: Pass/No Pass [X] Standard Letter [X] Not Graded [ ]
OPEN ENTRY/OPEN EXIT: Yes [ ] No [X]
TRANSFER STATUS: CSU Transferable[ ] UC/CSU Transferable[X] Not Transferable[ ]
BASIC SKILLS STATUS: Yes [ ] No [X] **LEVELS BELOW TRANSFER:** Not Applicable
CALIFORNIA CLASSIFICATION CODES: Y - Not Applicable
NON CREDIT COURSE CATEGORY: Y - Not applicable, Credit Course
OCCUPATIONAL (SAM) CODE: E
REPEATABLE ACCORDING TO STATE GUIDELINES: No [X] Yes [ ] NUMBER REPEATS:
REQUIRED FOR DEGREE OR CERTIFICATE: No [X] Yes [ ]
GE AND TRANSFER REQUIREMENTS MET:

IGETC Area 2: Mathematical Concepts and Quantitative Reasoning

2A: Mathematic

CSU GE Area B: Scientific Inquiry and Quantitative Reasoning

B4 - Mathematics/Quantitative Thinking

COURSE LEVEL STUDENT LEARNING OUTCOME(S) Supported by this course:

1. Use elementary tensor methods for calculating generalized derivatives in Riemannian spaces.
2. Demonstrate the ability of proving theorems for the calculus of R^n.
3. Employ the exterior calculus in generalized Stokes' theorems, especially as applicable to manifold theory.

COURSE OBJECTIVES:

1. Use the Einstein summation convention.
2. Use basic linear algebra for tensors.
3. Employ elementary tensor coordinate transformations.
4. Perform tests for tensor character.
5. Discuss the metric tensor and its relation to inner products.
6. Use the calculus of tensor derivatives.
7. Explain the relationship between tensors and Reimannian curves and Riemannian curvature.
8. Discuss proofs and uses of the inverse and implicit function theorems for Rn.
9. Employ elementary sets of measure zero.
10. Prove the change of variable theorem.
11. Use fields and differential forms.
12. Explain integration on chains and its relationship to the fundamental theorem of calculus.
13. Employ simple manifolds and elementary tensor fields on manifolds.
14. Prove and use the generalized Stoke's theorem on manifolds.
15. Explain the relationship between the generalized Stoke's theorem and classical theorems.
16. Prove simple theorems about the topology of Rn including notions of interior, exterior, boundary, compactness and connectedness.
17. Prove the Fubini theorem for Rn.
18. Employ elementary partitions of unity.

COURSE CONTENT:

LECTURE CONTENT:

It is imperative that instructors cover all topics in the outline. The instructor may determine the order of topics.

1. Review Exterior Algebra
   a. duel spaces and the calculus
   b. bases
   c. formalism
   d. adjoints
   e. tangent bundles
   f. calculus on tangent bundles

2. Tensor Calculus
    a. The Einstein notation
    b. linear algebra for tensors
    c. contravariant and covariant coordinates
    d. types of tensors
    e. invariants
    f. operations
    g. the metric tensor
    h. Christoffel symbols
    i. covariant differentiation
    j. absolute differentiation
    k. tensors and dual spaces
    l. introduction to manifolds
    m. tensors on manifolds
3. Euclidean Space
    a. norm and inner product
    b. compactness and the finite Tychonoff theorem
    c. continuity and oscillation
4. Differentiation
    a. definition and uniqueness
    b. basic theorems and proofs

c. differentiability criterion
d. inverse function theorem
e. implicit function theorem

5. Integration
    a. definition and fundamental criterion

b. measure zero
c. integrability

    d. Fubini's theorem
    e. partitions of unity
    f. change of variable theorem

6. Integration on Chains
    a. more exterior algebra
    b. tangent spaces and differential forms

c. singular *n* cubes and boundaries

d. functional theorem (generalized Green's)

7. Review of Differential Geometry

a. curves and Frenet formulas

b. definition of surfaces

c. fundamental forms

d. Gaussian curvature

e. introduction to Riemannian geometry

8. Integration on Manifolds

a. definitions and their equivalences

b. fields and forms on manifolds

c. generalized Stokes' theorem

d. elements of hypervolume

e. classical theorems

LABORATORY CONTENT:

METHODS OF INSTRUCTION:

A. Lecture:
B. Independent Study:

INSTRUCTIONAL TECHNIQUES:

Lecture, discussion

COURSE ASSIGNMENTS:

Reading Assignments

As assinged from textbooks. 1 hour

Out-of-class Assignments

Students write definitions, theorems, proofs, and justifications. 8 hour

Writing Assignments

Students write definitions, theorems, proofs, and justifications. 1 hour

METHODS OF STUDENT EVALUATION:

Midterm Exam
Final Exam
Short Quizzes
Written Assignments
Essay Examinations
Objective Examinations
Problem Solving Exercises

Demonstration of Critical Thinking:

Problem solving exercises, theorems, proofs, justifications

Required Writing, Problem Solving, Skills Demonstration:

Students write definitions, theorems, proofs, and justifications

TEXTS, READINGS, AND RESOURCES:

TextBooks:

1. Kay, David. *Schaum's Outline of Tensor Analysis*, ed. New York: McGraw Hill, 2011
2. Spivak, Michael. *Calculus on Manifolds*, ed. Atlanta: Perseus Publishing, 1973

Other:

1. Other appropriate textbook as chosen by faculty.

LIBRARY:

Adequate library resources include: Print Materials
Non-Print Materials
Online Materials
Services

Comments:

Attachments:

Attached Files