CGS Agenda Item: 22-02
Effective Spring 2024

Eastern Illinois University

New/Revised Course Proposal Format

(Approved by CAA on 4/3/14 and CGS on 4/15/14, Effective Fall 2014)

Banner/Catalog Information (Coversheet)

1. **__X__New Course or _____Revision of Existing Course**
2. **Course prefix and number:** ___MAT 5020_____
3. **Short title:** _____Dynamical Systems_____
4. **Long title:** ___Dynamical Systems and Fractal Geometry_____
5. **Hours per week:** __4_ Class __0_ Lab __4_ Credit
6. **Terms:** ___ Fall ___ Spring ___ Summer __x_ On demand
7. **Initial term**: ___ Fall __x_ Spring ___ Summer Year: ___2024___
8. **Catalog course description:** A mathematical examination of the concepts of self-similarity, fractals, and chaos through looking at phase space, bifurcations, chaos, the butterfly effect, and strange attractors.
9. **Course attributes:**

   General education component: ___N/A_____

   ___ Cultural diversity ___ Honors ___ Writing centered ___ Writing intensive ___Writing active

   ___ Department Capstone as Senior Seminar

10. **Instructional delivery**
    Type of Course:

    _X__ Lecture ___ Lab ___ Lecture/lab combined ___ Independent study/research

    ___ Internship ___ Performance ___ Practicum/clinical ___ Other, specify: _____

    Mode(s) of Delivery:

    __X_ Face to Face ___ Online Synchronous _X__ Online Asynchronous ___ Study Abroad

    ___ Hybrid, specify approximate amount of on-line and face-to-face instruction_____
11. **Course(s) to be deleted from the catalog once this course is approved:**
    __N/A_____
12. **Equivalent course(s):** __N/A_____

    a. Are students allowed to take equivalent course(s) for credit? ___ Yes __X_ No
13. **Prerequisite(s):** __MAT 2442; MAT 2550 or MAT 4760_____

    a. Can prerequisite be taken concurrently? ___ Yes _X__ No

b. Minimum grade required for the prerequisite course(s)? _C__

c. Use Banner coding to enforce prerequisite course(s)? _X__ Yes ___ No

d. Who may waive prerequisite(s)?

___ No one __X_ Chair __X_ Instructor ___ Advisor ___ Other (specify)

14. Co-requisite(s): _____

15. Enrollment restrictions

a. Degrees, colleges, majors, levels, classes which <u>may</u> take the course: __ Graduate students in Mathematics – Secondary Mathematics Education option _____

b. Degrees, colleges, majors, levels, classes which may <u>not</u> take the course: _Everyone else_____

16. Repeat status: _X__ May not be repeated ___ May be repeated once with credit

17. Enter the limit, if any, on hours which may be applied to a major or minor: _4__

18. Grading methods: __X_ Standard ___ CR/NC __ Audit ___ ABC/NC

19. Special grading provisions:

_N/A__ Grade for course will <u>not</u> count in a student's grade point average.

_ N/A __ Grade for course will <u>not</u> count in hours toward graduation.

_ N/A __ Grade for course will be removed from GPA if student already has credit for or is registered in: _____

_ N/A __ Credit hours for course will be removed from student's hours toward graduation if student already has credit for or is registered in: _____

20. Additional costs to students:
Supplemental Materials or Software___N/A_____

Course Fee _X__No ___Yes, Explain if yes_____

21. Community college transfer:

___ A community college course may be judged equivalent.

_X__ A community college may <u>not</u> be judged equivalent.

Note: Upper division credit (3000+) will <u>not</u> be granted for a community college course, even if the content is judged to be equivalent.

Rationale, Justifications, and Assurances (Part I)

1. ___Course is required for the major(s) of _____
   ___Course is required for the minor(s) of _____
   ___Course is required for the certificate program(s) of _____
   _X__ Course is used as an elective
2. **Rationale for proposal**: Dynamical systems and fractal geometry are highly accessible graduate level topics that incorporate several different areas of mathematics which makes it an ideal course for the mathematics education graduate program. Additionally, several ideas used in the course could be incorporated into the secondary classroom and are of use in later analysis courses.
3. **Justifications for (answer N/A if not applicable)**
   Similarity to other courses: N/A
   Prerequisites: The class requires background knowledge of complex arithmetic and operations as learned in MAT 2442. Additionally, matrix arithmetic and linear combinations/transformations are important ideas needed for the course and is learned in MAT 2550/4760.
   Co-requisites: N/A
   Enrollment restrictions: This is a graduate level class and requires an undergraduate background in mathematics.
   Writing active, intensive, centered: N/A
   Capstone as Senior Seminar: N/A
4. **General education assurances (answer N/A if not applicable)**
   General education component: N/A
   Curriculum: N/A
   Instruction: N/A
   Assessment: N/A
5. **Online/Hybrid delivery justification & assurances (answer N/A if not applicable)**
   Online or hybrid delivery justification: Most often, students taking this class will be located off-campus. Other similar classes have been offered online successfully.
   Instruction: Online delivery of the class will be facilitated through the EIU Learning Management System. Materials will include professor-recorded/selected videos, notes, discussions and other components. Faculty teaching the class online will have the appropriate

OCDI training. The EIU LMS provides various ways for work to be securely given and collected. Assignments will be checked for integrity using available tools.

Interaction: The EIU LMS allows for discussion boards to be posted on and video collaboration. The professor will give feedback and interact with students via these methods, online office hours, and online class meetings if and when necessary. The discussion board tools also allow students to interact with each other.

Model Syllabus (Part II)

1. Course number and title

MAT 5020 - Dynamical Systems and Fractal Geometry

2. Catalog description

A mathematical examination of the concepts of self-similarity, fractals, and chaos through looking at phase space, bifurcations, chaos, the butterfly effect, and strange attractors.

3. Learning objectives.

The student will be able to:

(a) explain what makes a dynamical system (1,2, 3);
(b) determine orbits, fixed points, and periodic points (1,2);
(c) calculate and represent bifurcations (1,2,3);
(d) describe what makes a metric space (1, 2);
(e) describe and work with fractals (1,2,3);
(f) work problems with the Julia set (1,2);
(g) work problems with the Mandelbrot set (1, 2).

4. Course materials.

"A First Course in Chaotic Dynamical Systems" by Robert Devaney (CRC Press, 2020)
Supplemental Text: "Fractals Everywhere" by Michael Barnsley (Dover, 2012)

5. Weekly outline of content.

Week 1: Dynamical Systems Fundamentals

Week 2: Orbits

Week 3: Graphical Analysis

Week 4: Fixed and Periodic Points

Week 5: Bifurcations

Week 6: Quadratics and Complex Functions

Week 7: Chaotic Behavior

Week 8: Metric Space and the Space of Fractals

Week 9: Transformations on Metric Spaces

Week 10: Construction of Fractals

Week 11: Chaotic Dynamics

Week 12: Fractal Dimension

Week 13: The Julia Set

Week 14: The Mandelbrot Set

Week 15: Other Dynamical Systems

Week 16: Final Exam

6. Assignments and evaluation, including weights for final course grade.

   Homework 25%
   Discussions/Participation 25%
   Written Exams 50%

7. Grading scale.

   100% - 90%A, 80-89.9% B, 70-79.9% C, 60-69.9% D, < 60% F.

8. Correlation of learning objectives to assignments and evaluation.

	Homework (25%)	Discussion (25%)	Exams (50%)
(a) explain what makes a dynamical system (1, 2, 3)	x	x	x
(b) determine orbits, fixed points, and periodic points (1, 2)	x		x
(c) calculate and represent bifurcations (1, 2, 3)	x	x	x
(d) describe what makes a metric space (1, 2)	x		x
(e) describe and work with fractals (1, 2, 3)	x	x	x
(f) work problems with the Julia set (1, 2)	x		x
(g) work problems with the Mandelbrot set (1, 2)	x		x

Date approved by the department or school: 12/6/21
Date approved by the college curriculum committee: 1/19/22
Date approved by the Honors Council *(if this is an honors course):*
Date approved by CAA: CGS: