COURSE APPROVAL FORM, Graduate School
University of Arkansas for Medical Sciences

This form and attached materials are due in the Graduate School Office on the first Monday of the month. All forms will be submitted to the UAMS Graduate Council Curriculum Committee for review and approval prior to consideration by the Graduate Council.

This form is not required for minor stylistic or editorial corrections to the title or course descriptions. These may be made when revising the catalog copy.

1. **Program:** Biomedical Informatics (*Department*) | D | B | M | I | | | | | (*Alpha (Department) Code*)

2. **Action proposed** (indicate one or more items): Effective term: Fall 2017

☐	Add course	☒	Change title	
☐	Eliminate course (No outline needed)	☒	Change credit hours from:	3 to 4
		☐	Change course number from:	to
		X	Change description	

3. **Course ID, title and description:**

prefix	number	title (20 characters)
B M I G	5 0 1 1	Intro to BMI I

Introduction to Biomedical Informatics I
catalog name (40 characters)

Scheduled offering: ☒ Fall ☐ Spring ☐ Summer ☐ On demand

To cross list a course, use the Course Cross Listing Form.

Describe the course in sentence form using 50 words or less **as it is to appear in the catalog**. List prerequisites, co-requisites and possible off-site instructional opportunities or requirements.

Introduces key application areas, thought leaders, seminal work and methods common across Biomedical Informatics. Major topics include defining the discipline, information flow at the molecular and cellular level, declarative, probabilistic and procedural knowledge, Biomedical ontology, relational theory, and concepts involving development, implementation, use, and evaluation of computer systems in biomedicine.

4. **Justification:**

Justify this change in terms of course needs or curriculum improvement. State the effect of this change on any degree programs. Identify the courses to be eliminated, if any, if this course is approved. (Course Approval Forms must also be submitted for these courses) Identify any existing course or courses that would extensively overlap or be duplicated if the proposed curricular change occurs. Provide statements of concurrence with the change from the chairperson(s) and dean(s) of the programs/areas offering the affected courses.

Both the External Advisory Committee and the review statements from the federal T15 grant noted that the core courses for the DBMI curriculum should be expanded. This change reflects the need to expand the content of the program's core courses. The title should b changed from "Introduction to Biomedical Informatics" to "Introduction to Biomedical Informatics I". The hours increased from 3 credit hours to 4 credit hours because of the addition of the 1 credit hour lab.

INSTRUCTIONS FOR COMPLETION OF THE UAMS GRADUATE SCHOOL COURSE APPROVAL FORM

1. Please save this PDF to your computer for editing.

2. The form has been designed with fields for your responses, and these are indicated in blue and gray shading. Please complete all fields. Use the "tab" key to move between fields. A 'beep' will sound if you attempt to enter a response that contains more characters than is permitted. IF YOU NEED HELP IN ANY OF THE FIELDS, PRESS THE F1 KEY AND A HELP WINDOW WILL OPEN.

3. Print the document, and then obtain the appropriate signatures before submitting the form to the Graduate Office.

5. Course Information: *This information is not required for seminars, special problems, research, thesis, dissertation, colloquia, practica, etc.*

Course Title and Course number: *See Graduate School Office for assignment of course number.*

Credit Hours:

Proposed Date/Semester:

Course Description: *Briefly describe course topics and educational materials the course will cover.*

Course Goals or Objectives: *State at least one: examples.*

- To evaluate ...
- To demonstrate ...
- To measure...
- To conduct ...
- To be able to ...

Course Prerequisites: *State if any; if none, indicate "No prerequisites."*
The prerequisites are...

Attendance: *See example below.*
Attendance is required for all classes. Excused absences may be obtained only by permission from the course director. Make-up exams will only be given under the most extenuating circumstances.

Student Evaluation: *See examples below;*
This is a pass/fail course. A grade of 70% or greater will constitute a "pass".
Students' grades will be based on the following:

Attendance, discussion of reading, class/lab participation..... 20%
Final Examination 80%
TOTAL.....100%

Course Evaluation: *See example below; include evaluation by faculty peers as well as by students.*
At the end of the course, students will be provided with a Course Evaluation Form to anonymously assess the content and delivery of the course. Faculty will assess the course each term and make any appropriate modifications and updates.

Textbooks/Reading Materials: *See examples below.*
Textbook XXX along with other assigned reading will be used.
There will be no textbook but journal articles will be assigned reading.
Students will be e-mailed a copy of the PowerPoint presentations before each lecture.

Course Director(s): Dr. XXX

Tentative Course Schedule:

Session	Date	Topic	Instructor
1			
2			
3			
4			
5			
6			

6. **Program Approvals:**

Fred Prior, PhD, Department of Biomedical Informatics
(Print or type) Chairperson, Academic Department or Area

Fred Prior 05/15/2017
(Signature) Chairperson, Academic Department or Area Date

College Dean (Dean McGehee for College of Medicine) Date

7. **Graduate School Approvals**

Chairperson, Graduate Council Date

Dean of the Graduate School Date

SYLLABUS

COURSE NUMBER: BMIG 5011

COURSE TITLE: Introduction to Biomedical Informatics I

COURSE DESCRIPTION:

This graduate course is the first part of a two course introduction to the discipline of biomedical informatics. The student is introduced to the discipline through key application areas, thought leaders, seminal work and methods common across Biomedical Informatics. Major topics covered include defining the discipline, information flow at the molecular and cellular level, declarative, probabilistic and procedural knowledge, Biomedical ontology, relational theory, and basic concepts involving development, implementation, use, and evaluation of computer systems in biomedicine.

This two-part course series serves as the foundation for the Biomedical Informatics Graduate Program educational goals by providing a survey of the discipline and general awareness of the major areas of practice and cross-cutting concepts, theories and methods. The didactic portion of the course offers students the opportunity to internalize the goals and value of the discipline to human health. The lab portion of the course offers hands-on exposure to and experience with methods and tools used across the discipline. After the course, the student should have a comfort level discussing areas of practice and digesting research findings.

PRE-REQUISITES: None

GENERAL INFORMATION:

CREDITS: Didactic portion – 3 credit hours
Lab portion – 1 credit hour

SEMESTER: Fall

LOCATION: Campus and Online (hybrid)

FACULTY: Meredith Zozus, PhD

SPECIAL ASSISTANCE: Students who believe they may need accommodations in this class based on mental or physical impairments must contact the Students with a disability that need accommodations should contact the Associate Dean for Academic Affairs at (501) 686-5730 to schedule an appointment to discuss your needs. Please make

arrangements as soon as possible so accommodations can be made in a timely manner.

COURSE OBJECTIVES:

Upon successful completion of this course, the student is able to:

Articulate the scope, goal, and definition of Biomedical Informatics as a discipline and of professions within the discipline based on accepted frameworks

Describe the impact of historical seminal contributions to Biomedical Informatics and human health

Apply ten cross-cutting principles, theories or methods to addressing one or more major challenges facing Biomedicine

Examine the goals and focus of major Biomedical Informatics organizations and journals.

Engage in critical reflection of ones strengths and interests in relation to major Biomedical Informatics roles.

MAJOR TOPICS:

Introduction to the Discipline
Definition of Biomedical Informatics as a discipline
Careers and Professional organizations in Biomedical Informatics
History of Biomedical Informatics
Major challenges in Biomedicine

Computer Systems in Biomedicine
Computer systems, networks and architecture
Information systems lifecycle and software engineering concepts
Knowledge acquisition, representation, management and application
Interoperability

Cross-cutting Concepts, Principles and Theories
Fundamentals of Data, Information, and Knowledge
Semiotics and Representation Theory
Terminology, data elements, ontology, and data models as representations
Relational theory
Declarative, probabilistic and procedural knowledge in biomedicine
Extracting knowledge from data (data and text mining)
Information and resource indexing and retrieval

COURSE OUTLINE:

Week 1 **Introduction to the discipline of Biomedical Informatics**

Lectures: (1) Definition and history of Biomedical Informatics including professional societies and journals; (2) Publishing and presenting as a student

Reading: Shortliffe and Cimino Chapter 1 Biomedical Informatics, the science and pragmatics; Friedman 2009, Friedman 2013

Assignment: Discussion forum post involving what is and isn't informatics.

Lab: Introduction to the lab portion of the course; check access to tools used this semester

Week 2 **Genetic sequences as biological information**

Lectures: (1) Genomics and genomic-based information flow, (2) Transcriptomics and proteomics

Reading: Shortliffe and Cimino Chapter 24 Bioinformatics

Assignment: Discussion forum post - present a new example of data in the natural world

Lab: BLAST-like matching for organism identification

Week 3 **Metagenomics and community structures**

Lectures: (1) Metagenomics, (2) Community structures

Reading: Torsten Thomas, Jack Gilbert and Folker Meyer, Metagenomics – a guide from sampling to data analysis.

Assignment: Discussion forum post – present an application of metagenomics in clinical or public health practice

Lab: Metagenomics demonstration

Week 4 **Translational Bioinformatics and Bioinformatics in clinical medicine**

Lectures: (1) Translational bioinformatics, (2) Information about genes and gene products used in clinical practice, e.g., results from Non Invasive Prenatal Testing (NIPT)

Reading: Shortliffe and Cimino Chapter 25 Translational Bioinformatics

Assignment: Discussion forum post – present an application of –omics in clinical or public health practice

Lab: Analysis of gene variation in malignant tumors

Week 5 **Informatics and Clinical and Translational Research**

Lectures: (1) Clinical Research Informatics, (2) Informatics in the Clinical and

Translational Research Cycle

Reading: Shortliffe and Cimino Chapter 26; National Center for Advancing Translational Sciences (NCATS) interactive web pages "About Translation" https://ncats.nih.gov/translation

Assignment: (1) Discussion forum post – describe a problem in Clinical and Translational Research and suggest a way in which Biomedical Informatics may help overcome it. (2) (2) List two good Clinical Research Informatics journals or meetings.

Lab: For a disease or disorder, use the National Guidelines Clearinghouse to identify relevant clinical guidelines; use PubMed and Web of Science to identify articles published since the guideline that report research results that may be relevant to updating the guideline in the future. Characterize your results in terms of percent of the total search results likely relevant to the guideline update based on your screening of the title and abstract. Describe the process through which research such as clinical trial results make it to clinical guidelines.

Week 6 **Biomedical data**

Lectures: (1) Data, Information, Knowledge and Semiotics (2) Data collection and use in clinical settings

Reading: Luciano Floridi, Semantic Conceptions of Information; Shortliffe and Cimino Chapter 2 Biomedical data: their acquisition, storage and use

Assignment: Discussion forum post – Compare and contrast uses of data in biomedicine with uses in other areas such as manufacturing, commerce and finance.

Lab: For a given biomedical scenario, identify data collected or used and categorize the data in terms of fundamental kinds of data.

Week 7 **Declarative knowledge: facts in the real world**

Lectures: (1) Biomedical ontology, (2) Triplets, graph theory and graph visualization

Reading: Barry Smith, Michael Ashburner, Cornelius Rosse, *et. al.*, The OBO Foundry: coordinated evolution of ontologies to support biomedical data integration; James. J. Cimino, Desiderata for Controlled Medical Vocabularies in the Twenty-First Century

Assignment: Discussion forum post involving declarative versus procedural knowledge.

Lab: OWL

Week 8 **Declarative knowledge: data we collect about things in the real world**

Lectures: (1) Data elements and Controlled terminology, (2)

Reading: Shortliffe and Cimino Chapter 7; E.F. Codd, A relational model of data for large shared databanks. Communications of the ACM, 13:6, 1970.

Assignment: Discussion forum post involving identifying data standards for a given domain.

Lab: Unified Modeling Language (UML), use Enterprise Architect to create an entity-relationship diagram for 50 data elements or less about (1) patients, encounters, vital signs, labs and medications, or (2) patients, biological samples, and common –omics assays run on those samples, or (3) patients, diagnoses, and clinical images.

Week 9 **Relational theory and data models**

Lectures: (1) Relational theory, logical data models including data warehouse models (2) Common data models, (3) Structured Query Language (SQL)

Reading: Shortliffe and Cimino Chapter 7; E.F. Codd, A relational model of data for large shared databanks. Communications of the ACM, 13:6, 1970.; Robert Rees, NoSQL, No Problem: An Introduction to NoSQL Databases. 2010, https://www.thoughtworks.com/insights/blog/nosql-no-problem-intro-nosql-databases

Assignment: Discussion forum post involving comparing and contrasting different models for organizing data including, relational, hierarchical, network, graph, and noSQL.

Lab: Create tables using SQL Data Definition Language (DDL) for your data model using an open source Relational Database Management System (RDBMS). Use an insert statement to populate the tables with data for two patients. Write SQL statements to retrieve the data you inserted for one patient but not the other.

Week 10 **Probabilistic Knowledge**

Lectures: (1) Test characteristics and Bayes' Theorem, (2) Machine Learning

Reading: Shortliffe and Cimino Chapter 3: Biomedical Decision-making; Mario F. Triola, Bayes' Theorem by http://faculty.ccp.edu/faculty/sgramlich/152/Bayes.pdf; Nick McCrea, An Introduction to Machine Learning Theory and Its Applications: A Visual Tutorial with Examples. 2014, https://www.toptal.com/machine-learning/machine-learning-theory-an-introductory-primer

Assignment: Discussion forum post involving working example problems involving test characteristics (Sensitivity, Specificity, PPV, NPV, ROC curve) and Bayes' problems.

Lab: Create a Bayes Net for a given clinical problem

Week 11 **Procedural Knowledge**

Lectures: (1) Diagraming work and data flow, (2) Rules-based systems

Reading: Shortliffe and Cimino Chapters 12: Electronic Health Record Systems and 22: Clinical Decision Support Systems, Zozus Chapter 11: Designing and documenting data flow and workflow.

Assignment: Discussion forum post – Give an example of an aspect of EHR systems that

enforce or support workflow. Describe the rules involved in your chosen EHR supported or enforced workflow.

Lab: Rules engine use.

Week 12 **Knowledge Acquisition, Representation, Management, and Application in Biomedical Informatics**

Lectures: (1) Manual KARMA methods, (2) Data mining KA methods

Reading: Shortliffe and Cimino Chapter 6: Software engineering in healthcare and biomedicine; Selected chapters (provided) from Milton

Assignment: Discussion forum post – State and support an opinion whether or not Biomedical Informatics engineering requires biomedical content knowledge.

Lab: Given a design problem, devise and describe appropriate KARMA methods

Week 13 **Computer systems in healthcare and biomedicine**

Lectures: (1) Boolean logic, (2) Architecture , networks, interoperability and security

Reading: Shortliffe and Cimino Chapter 5: Computer architectures for healthcare and biomedicine

Assignment: Discussion forum post – Discuss the advantages and disadvantages of monolith EHR systems over best of breed and home grown systems.

Lab: Boolean logic/logic diagram problems

Week 14 **Software engineering concepts in biomedicine**

Lectures: (1) Information system lifecycle part 1: needs assessment, software design and development, or selection, and testing, (2) Information system lifecycle part 2: implementation, migration, evaluation, maintenance, downtime, and decommissioning.

Reading: Shortliffe and Cimino Chapter 11: Evaluation of Biomedical and health information resources

Assignment: Discussion forum post – describe the informaticists role in software engineering in Biomedicine. Support your answer.

Lab: Choose either a Lab Information System (LIMS) or a Practice Management System in a private practice, medical office setting. Draft a two page plan for software selection, testing, implementation and maintenance, or a plan for software development and validation.

Week 15 **Information retrieval and digital libraries**

Lectures: (1) Information curation and retrieval, (2) Review session for the exam

Reading: Shortliffe and Cimino Chapter 21: Information retrieval and digital libraries

Assignment: Discussion forum post – State and support an opinion on the following topic: with the current state of text searching, do we need to index the biomedical literature?

Lab: Use the MeSH browser to pick MeSH terms appropriate to index your history poster.

Discussion forum posts: Discussion forum posts require engagement with other students and responses to the posts of others. A successful discussion forum post shows your understanding of the relevant material as well as your ability to critically and constructively evaluate the posts of others toward a better overall treatment of the topic. If you agree with the post of another student; state why you agree. If you disagree; state why. If you can offer an additional perspective on the topic or contribute to improving the treatment of the topic, please do so – the point is to as a group, fully characterize the assigned topic. The following table is provide as a guide to successful participation in the discussion forums for the course.

	Characteristics of Individual Discussion Forum Posts	Points
No value	No entry, late entry after deadline, simple agreement	0
Simple Comment	Response(s) indicates no evidence of interaction with other participants' postings.	0
Static Comment	Response(s) shows evidence of a connection with other participants' postings but does not move the conversation forward in a meaningful way; does not enhance or expand the discussion.	0.5
Generative Comment	Response(s) builds on the ideas of other participants and digs deeper into assignment questions or issues. New material (beyond assigned readings) may be introduced. An example from a personal or professional experience provides a new perspective on, facet of, or avenue for exploration within the forum.	1
Collaborative and Synthesizing Comment	Response(s) integrates multiple views or shows value as a seed for reflection by other participants' responses in its thread. Alternatively, the response contributes content that serves to deepen the dialogue. Such threads moderate and synthesize the discussion for all.	1.5

Points are assigned by the week. Fifteen points earns 15% of the course grade. You can earn additional points for exceptional (collaborative and synthesizing posts) up to a maximum of 5 extra credit points toward the course total of 100 total points.

Weekly quizzes: Weekly quizzes are a formative evaluation, i.e., they are meant to help you check and improve your learning. For this reason, points missed on weekly quizzes can be earned back by posting in the weekly quiz discussion forum (1) the question you missed, (2) what the correct answer is and (3) an explanation of why you missed it. The weekly quiz discussion forum will open after the quiz closes each week. Posting about questions you missed requires some humility and introspection and is optional. Please consider participating in this way; your learning and questions will help everyone master the material in greater depth.

Course Project: Present an overview in poster format of your assigned History topic. Describe the theories and pioneering people and systems, application area or BMI challenge addressed, and how the advance reflected the Tower of Achievement and achieved the Fundamental Theorem.

EVALUATION:

This is a graded course. Grades will be assigned separately for the didactic and lab portion of the course based on the course average according to the following scale: A (93-100), B (85-92), C(75-84), D(65-74), Fail (lower than 64).

The course average for the didactic portion of the course will be comprised of course assignments, weekly quizzes, the course project, and the final exam. The didactic portion of the course represents three of the four credit hours.

Assignments.....15%
Weekly quizzes.....35%
Course project.....25%
Final exam.....25%

The course average for the lab portion of the course will be comprised of the graded lab assignments, evenly weighted. The lab portion of the course represents one of the four credit hours.

ADDITIONAL RESOURCES:

1. Oregon Health & Science University wiki http://clinfowiki.org/wiki/index.php/
2. Friedman, Charles P., A "Fundamental Theorem" of Biomedical Informatics. *J Am Med Inform Assoc*, Volume 16, Issue 2, Pages 169-170, 2009.
3. Friedman CP. What informatics is and isn't. J Am Med Inform Assoc. 2013 Mar-Apr;20(2):224-6.
4. Gardner RM, Overhage JM, Steen EB, Munger BS, Holmes JH, Williamson JJ, Detmer DE; AMIA Board of Directors. Core content for the sub-specialty of informatics, J Am Med Inform Assoc. 2009 Mar-Apr;16(2):153-7.
5. Gadd CS, Williamson JJ, Steen EB, Fridsma DB.bCreating advanced health informatics certification. J Am Med Inform Assoc. 2016 Jul;23(4):848-50.
6. Torsten Thomas, Jack Gilbert and Folker Meyer, Metagenomics – a guide from sampling to data analysis. Microbial Informatics and Experimentation20122:3 https://microbialinformaticsj.biomedcentral.com/articles/10.1186/2042-5783-2-3
7. Barry Smith, Michael Ashburner, Cornelius Rosse, *et. al.*, The OBO Foundry: coordinated evolution of ontologies to support biomedical data integration. Nat Biotechnol. 2007 Nov; 25(11): 1251. http://www.nature.com/nbt/journal/v25/n11/full/nbt1346.html
8. Floridi, Luciano, "Semantic Conceptions of Information", The Stanford Encyclopedia of Philosophy (Spring 2017 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/spr2017/entries/information-semantic/>.
9. James.J. Cimino, Desiderata for Controlled Medical Vocabularies in the Twenty-First Century. Methods Inf Med. Author manuscript; available in PMC 2012 Aug 10. Published in final edited form as: Methods Inf Med. 1998 Nov; 37(4-5): 394–403.

10. Codd, A relational model of data for large shared databanks. Communications of the ACM, 13:6, 1970. https://www.seas.upenn.edu/~zives/03f/cis550/codd.pdf
11. Robert Rees, NoSQL, No Problem: An Introduction to NoSQL Databases. 2010, https://www.thoughtworks.com/insights/blog/nosql-no-problem-intro-nosql-databases
12. Bayes' Theorem by Mario F. Triola http://faculty.ccp.edu/faculty/sgramlich/152/Bayes.pdf
13. Nick McCrea, An Introduction to Machine Learning Theory and Its Applications: A Visual Tutorial with Examples. 2014, https://www.toptal.com/machine-learning/machine-learning-theory-an-introductory-primer

TEXTBOOKS:

Edward H. Shortliffe, James J. Cimino, Eds., Biomedical Informatics: Computer Applications in Health Care and Biomedicine. Springer-verlag, London, 2014.

OPTIONAL (due to cost) Morris F. Collen and Marion J. Ball Eds.The History of Medical Informatics in the United States 2nd Edition. Springer-Verlag, London 2015

OPTIONAL (due to cost and limited use in this course) Nicholas Ross Milton, Knowledge Acquisition in Practice: A Step-by-step Guide (Decision Engineering) May 1, 2007, Springer.

OPTIONAL (due to cost and limited use in this course) Grigoris Antoniou, Paul Groth, Frank van Harmelen, Rinke Hoekstra, A Semantic Web Primer (Information Systems) 3rd Edition. MIT Press, Cambridge Mass, 2012.

Link to UAMS Online Bookstore:
http://uams.textbookx.com/institutional/index.php?action=browse#books/1552684/