4/1/4. Course Specification:

COURSE SPECIFICATIONS

Form

Course Title: **Advanced Mathematical Methods (2)**

Course Code: **4046505-4**

Course Specifications

Institution: Umm Al-Qura University Date: 31/10/2018
College/Department: Faculty of Applied Science/ Department of Mathematical Sciences

A. Course Identification and General Information

1. Course title and code: Advanced Mathematical Methods (2) (4046505-4)				
2. Credit hours: 4 Hours				
3. Program(s) in which the course is offered. (If general elective available in many programs indicate this rather than list programs) Master in Mathematics				
4. Name of faculty member responsible for the course: Dr. Muntaser Safan				
5. Level/year at which this course is offered: Leve 3/ Master				
6. Pre-requisites for this course (if any) : Advanced Mathematical Methods (1)				
7. Co-requisites for this course (if any):				
8. Location if not on main campus: Al-Abidiyah campus and Al-Zahir campus				
9. Mode of Instruction (mark all that apply)				
a. traditional classroom	√	What percentage?	85	
b. blended (traditional and online)		What percentage?		
c. e-learning	√	What percentage?	15	
d. correspondence		What percentage?		
f. other		What percentage?		
Comments: The course is suitable for postgraduates at Master/Doctoral level.				

B Objectives

1. What is the main purpose for this course? The role of the course is to introduce a selection of advanced mathematical topics that are relevant to research in Applied Mathematics. It is likely that most students entering this course will have previously taken Advanced Mathematical Methods - Part I, but this is not essential. This course will focus on aspects of Dynamical and Integral Systems.
2. Briefly describe any plans for developing and improving the course that are being implemented. (e.g. increased use of IT or web based reference material, changes in content as a result of new research in the field) 1. Updating references used in teaching process. 2. Using e-learning facilities more efficiently. 3. Encouraging students to collect problems from web based references and supervise discussions in the class.

C. Course Description (Note: General description in the form used in Bulletin or handbook)

Course Description: This is a 4 credit course comprising approximately 52 hours of lectures.

1. Topics to be Covered		
List of Topics	No. of Weeks	Contact hours
Chapter 1 - Introduction Review properties of ordinary differential equations:- - Lipshitz condition - Existence and uniqueness of solution - Fixed point theory - Stability of fixed point algorithms - Linear stability analysis - Stable and overstable modes.	3	12

Chapter 2 - Bifurcation Theory - State what is meant by a bifurcation. - Introduce and describe the properties of various types of bifurcation, e.g. • Saddle Node bifurcation • Trans-critical bifurcation • Hopf bifurcation • Pitchfork bifurcation. - Give examples of these bifurcations with reference to dynamical problems from mechanics and biology etc. - Discuss uniform and non-uniform oscillators - Provide and investigate physical examples of each type of oscillator.	3	12
Chapter 3 - Two dimensional dynamical systems - Briefly review the concepts of Phase portrait, Orbits and Index Theory. - Introduce the concept of a Limit Cycle. - Introduce the Poincare-Bendixson Theorem. - Discuss relaxation oscillations and weakly nonlinear oscillations. - Introduce Poincare maps. - Provide physical examples illustrating these concepts.	3	12
Chapter 4 - Soliton equations - Discuss the meaning of integrability for Ordinary and Partial Differential equations. Introduce the notion of Lie symmetries and their role in the search for general solutions. - Introduce several examples of soliton equations with their histories, e.g. the Korteweg de Vries (KdV) and Sine-Gordon equations. - Derive the KdV equation and develop the classical one-soliton solution. Briefly discuss the properties of the two-soliton solution. - Introduce Backlund transformations and use them to treat the Sine-Gordon equation.	3	12

Chapter 5 - The inverse scattering transform - Introduce the concept of bound and scattering states, and wave function as understood within the framework of Quantum Mechanics. Introduce Schrodinger's equation and solve the problem of a particle held within a potential well. Discuss the meaning of the solution and contrast how the quantum and classical views of the world differ. - Describe the aim of the inverse scattering problem and why it is an important practical problem. State the Gelfand-Levitan-Marchenko (GLM) theorem. - Introduce the notion of a Quasi-Newton algorithm. - Discuss direct scattering in the context of the one-dimensional scattering of a particle on a potential. - Discuss the inverse scattering problem in one dimension by which the potential is recovered from reflected data and energy levels using the GLM theory. - State and prove Lax's theorem on the time independence of eigenstates. - Construct the N-soliton solution of the KdV equation and particularise it to the 2-soliton case to show that, asymptotically, two interacting solitons are not distorted by the interaction but that the interaction generates a phase shift.	3	12

2. Course components (total contact hours and credits per semester):

	Lecture	Tutorial	Laboratory or Studio	Practical	Other:	Total
Contact Hours	60	--				60
Credit	4	--				4

3. Additional private study/learning hours expected for students per week.
Four hours weekly for homework and revision

4. Course Learning Outcomes in NQF Domains of Learning and Alignment with Assessment Methods and Teaching Strategy

On the table below are the five NQF Learning Domains, numbered in the left column.

First, insert the suitable and measurable course learning outcomes required in the

appropriate learning domains (see suggestions below the table). **Second**, insert supporting teaching strategies that fit and align with the assessment methods and intended learning outcomes. **Third**, insert appropriate assessment methods that accurately measure and evaluate the learning outcome. Each course learning outcomes, assessment method, and teaching strategy ought to reasonably fit and flow together as an integrated learning and teaching process. (Courses are not required to include learning outcomes from each domain.)

Code #	NQF Learning Domains And Course Learning Outcomes	Course Teaching Strategies	Course Assessment Methods
1.0	**Knowledge: upon completion of this course, the student is expected to**		
1.1	Develop knowledge and understanding on the bifurcation Theory and its applications.	Lectures and tutorials	Short quizzes, periodical and final exams
1.2	Be aware of Poincare-Bendixson theorem and the inverse scattering transform.	Lectures and tutorials	Short quizzes, periodical and final exams
2.0	**Cognitive Skills: upon completion of this course, the student is expected to**		
2.1	Discuss relaxation oscillations and weakly nonlinear oscillations	Lectures and tutorials	Short quizzes, periodical and final exams
2.2	Discuss the meaning of integrability for Ordinary and Partial Differential equations. Introduce the notion of Lie symmetries and their role in the search for general solutions.	Lectures and tutorials	Short quizzes, periodical and final exams
3.0	**Interpersonal Skills & Responsibility: upon completion of this course, the student is expected to**		
3.1	Describe the aim of the inverse scattering problem and why it is an important practical problem. State the Gelfand-Levitan-Marchenko (GLM) theorem.	Lectures and tutorials	Short quizzes, periodical and final exams
3.2	Use Poincare-Bendixson Theorem in studying dynamical systems	Lectures and tutorials	Short quizzes, periodical and final exams
4.0	**Communication, Information Technology, Numerical: upon completion of this course, the student is expected to**		
4.1	Work effectively in groups and independently	Tasks assigned and homework	Marking the assignments.
4.2	Solve problems concerning the topics of the course.	Homework	Evaluating the homework
5.0	**Psychomotor**		
5.1	Not applicable	Not applicable	Not applicable

5. Schedule of Assessment Tasks for Students During the Semester			
	Assessment task (e.g. essay, test, group project, examination, speech, oral presentation, etc.)	Week Due	Proportion of Total Assessment
1	First midterm exam	Week 6	20
2	Second midterm exam	Week10	20
3	Homework and tutorial activities	Over all weeks	20
4	Final exam		40

D. Student Academic Counseling and Support

1. Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice. (include amount of time teaching staff are expected to be available each week) The instructor is available for at least 8 hours per week. He is also available on appointments.

E Learning Resources

1. List Required Textbooks - S.H. Strogatz, Nonlinear Dynamics and Chaos: With Applications To Physics, Biology, Chemistry, And Engineering (Studies in Nonlinearity), 2nd Ed. (2015). - L.D. Landau and E.M. Lifshitz, Course of Theoretical Physics. Vol I and II, Butterworth-Heinemann, (1995). - M. Dunajski, Solitons, Instantons and Twistors, Oxford Graduate Texts in Mathematics, OUP, (2009).
2. List Essential References Materials (Journals, Reports, etc.) **Journal of Advanced Mathematics and Applications**
3. List Recommended Textbooks and Reference Material (Journals, Reports, etc) **Advanced Mathematical Methods for Scientists and Engineers I**
4. List Electronic Materials, Web Sites, Facebook, Twitter, etc. **http://www.lmm.jussieu.fr/~lagree/COURS/M2MHP/Bender-Orszag-chap9-11.pdf** **--**
5. Other learning material such as computer-based programs/CD, professional standards or regulations and software.

Not applicable

F. Facilities Required

Indicate requirements for the course including size of classrooms and laboratories (i.e. number of seats in classrooms and laboratories, extent of computer access etc.)
1. Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.) Classroom with the capacity of 10-20 students
2. Computing resources (AV, data show, Smart Board, software, etc.) Smart board. - Classroom is equipped with a computer. - Provide projectors and related items. - Matlab software
3. Other resources (specify, e.g. if specific laboratory equipment is required, list requirements or attach list) Not applicable

G Course Evaluation and Improvement Processes

1 Strategies for Obtaining Student Feedback on Effectiveness of Teaching Student feedback on effectiveness of teaching.
2 Other Strategies for Evaluation of Teaching by the Instructor or by the Department Monitoring the achievement of the students in solving homework and periodical exams.
3 Processes for Improvement of Teaching Following up the student's homework. Encouraging the students to read and practice more.
4. Processes for Verifying Standards of Student Achievement (e.g. check marking by an independent member teaching staff of a sample of student work, periodic exchange and remarking of tests or a sample of assignments with staff at another institution) The instructors watch and give their feedbacks to their students through all work done by them, including exams to verify standards of achievements for different domains of learning outcomes
5. Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement. Reviewing the course reports submitted at the end of each semester.

Name of Instructor: Dr. Muntaser Safan
Signature:_ *Muntaser Safan* ___Date Report Completed: 31/10/218

Name of Field Experience Teaching Staff _____
Program Coordinator:_____
Signature: _____ Date Received:_____