4/1/4. Course Specification:

COURSE SPECIFICATIONS

Form

Course Title: **Advanced Numerical Analysis (2)**

Course Code: **4047708-4**

Course Specifications

Institution: Umm Al-Qura University Date: 8/10/2018
College/Department: Faculty of Applied Science/ Department of Mathematical Sciences

A. Course Identification and General Information

1. Course title and code: Advance Numerical Analysis (2) (4047708-4)
2. Credit hours: 4 Credit Hours
3. Program(s) in which the course is offered. (If general elective available in many programs indicate this rather than list programs) Doctor of Philosophy (Applied Mathematics)
4. Name of faculty member responsible for the course:
5. Level/year at which this course is offered: Level 3/ Ph. D.
6. Pre-requisites for this course (if any): Numerical Solutions of Differential Equations (1) 4046703-4
7. Co-requisites for this course (if any): Numerical Solutions of Differential Equations (2) 4047703-4
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:

B Objectives

1. What is the main purpose for this course? The role of the course is to introduce the principles of inverse theory and data assimilation with applications to geophysics and other sciences. Inverse theory refers to the mathematical techniques used to determine the parameters of a model that describes a set of observed data. It is assumed that students entering this course have previously taken the entry level course on Numerical Solutions of Differential Equations (1) and (2).
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 Ph. D. course introducing advanced topics in Numerical Analysis. The course comprises approximately 60 hours of lectures. The role of the course is to introduce the principles of inverse theory and data assimilation with applications to geophysics and other sciences. Inverse theory refers to the mathematical techniques used to determine the parameters of a model that describes a set of observed data. After the course the students are expected to understand basic mathematical and numerical methods to solve inverse problems related to partial differential equations. It is assumed that students entering this course have previously taken the entry level courses on Numerical Solutions of Differential Equations (1),(2).

1. Topics to be Covered		
List of Topics	No. of Weeks	Contact hours
Chapter 1 – Inverse problem and Fourier transforms - One dimensional inverse scattering problem. - Fourier transforms and well-posedness - Hilbert scale and ill-posedness.	3	12
Chapter 2 – Inverse kinematic problem - Kinematic Inverse Source Problem. - Kinematic velocity Inverse Problem.	2	8
Chapter 3 – Cauchy problem - Half Space Problem. - General two dimensional case. - Laplace equation on an annulus. - Riemann mapping theorem.	2	4
Chapter 4 – Regularization of ill-posed problems - Ill-posed problems and compact operators. - Regularity assumptions and error bound. - Regularization methods. - Tikhonov Regularization.	2	4
Chapter 5 – Transport equations - Transport equation. - Decomposition into singular components.	2	4
Chapter 6 – - Diffusion Equations - Introduction. - Exponential solutions . - The potential problem . - Inverse conductivity problem . - Stability result.	2	4

Chapter 7 – Reconstructing the domain of inclusions. - Forward Problem. - Factorization method. - Reconstruction of Σ.	2	4

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. 4

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**		
1.1	Have an enhanced knowledge and understanding of advanced topics in numerical analysis.	Lectures-Discussion-solve problems	Short quizzes, periodical and final exams.
1.2	Have the ability to recall the learned material of the course	Lectures-Discussion-solve	Short quizzes, periodical and

		problems	final exams.
2.0	**Cognitive Skills**		
2.1	Be able to apply the learned material of the course in real life problems.	Lectures-Discussion-solve problems	Short quizzes, periodical and final exams.
2.2	Be able to integrate related topics from separate parts of the course	Lectures – Discussion-solve problems	Short quizzes, periodical and final exams
3.0	**Interpersonal Skills & Responsibility**		
3.1	Have the ability to prove theorems and develop lemmas using different techniques	Lectures – Discussion-solve problems	Short quizzes, periodical and final exams
3.2	Be able to describe and analyze models using related equations	Lectures – Discussion-solve problems	Short quizzes, periodical and final exams
4.0	**Communication, Information Technology, Numerical**		
4.1	Have the ability to use computer programs in obtaining numerical solutions.	Discussion - Use Matlab, Mathematica or Numerical Packages to solve some problems numerically.	Homework projects
4.2			
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	Periodic exam (1)	6	20
2	Periodic exam (2)	10	20
3	Home work	Over all weeks	20
4	Final exam	End of semester	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) - Office hours are specified throughout the week (6 hours/week) - Contacts with students by e-mail, SMS, and e-learning facilities.

E Learning Resources

1. List Required Textbooks: - Richard Aster : Parameter Estimation and Inverse Problems. Academic Press, pp. 302, 2005, ISBN: 0-12-065604-3. - Carl Wunsch: Discrete Inverse and State Estimation Problems. Cambridge University Press, pp.384, 2006, ISBN: 0521854245.
2. List Essential References Materials (Journals, Reports, etc.)
3. List Recommended Textbooks and Reference Material (Journals, Reports, etc)
4. List Electronic Materials, Web Sites, Facebook, Twitter, etc.
5. Other learning material such as computer-based programs/CD, professional standards or regulations and software. Matlab, Mathematica and Numerical Packages

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.) Properly equipped classroom
2. Computing resources (AV, data show, Smart Board, software, etc.) - Classroom equipped with desktop computers. - Projectors and related items. - Numerical packages. - Compilers
3. Other resources (specify, e.g. if specific laboratory equipment is required, list requirements or attach list) Non

G Course Evaluation and Improvement Processes

1 Strategies for Obtaining Student Feedback on Effectiveness of Teaching Course evaluation questionnaire conducted electronically by the University at the end of the term.
2 Other Strategies for Evaluation of Teaching by the Instructor or by the Department - Results analysis. - Self- assessment of the program - External revisions and assessment. - Course report. - Annual reports sufficiently prepared by the head of department.
3 Processes for Improvement of Teaching - Application of modern technologies in the education. - Application of e-learning. - Programs and trainings to improve the skills of teaching and learning. Several workshops on the improvement of teaching are conducting yearly by the University.
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) Non
5 Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement. - Comparisons of the course with other institutes in other universities. - Reviewing process of courses for improvement and development is done normally every five years.

Name of Instructor:

Signature:_____Date Report Completed: 8/10/2018

Name of Field Experience Teaching Staff _____

Program Coordinator:_____

Signature: _____ Date Received:_____