**4/1/4. Course Specification:**

# COURSE SPECIFICATIONS

## Form

Course Title: Evolutionary Computation

Course Code: 14016485-3

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|---|---|
| **Date**: 2018 –10 – 21. | **Institution**: Umm Al-Qura University |
| **College**: College of Computer and Information Systems **Department**: Department of Computer Science | |

## A. Course Identification and General Information

1. Course title and code: Evolutionary Computation 14016485-3
2. Credit hours: 3
3. Program(s) in which the course is offered. Master of Computer Science (Artificial Intelligence)

   (If general elective available in many programs indicate this rather than list programs)
4. Name of faculty member responsible for the course Dr. Mohsin Bilal
5. Level/year at which this course is offered: 2/3
6. Pre-requisites for this course (if any):
7. Co-requisites for this course (if any):
8. Location if not on main campus:
9. Mode of Instruction (mark all that apply):

| | | | |
|---|---|---|---|
| a. Traditional classroom | | percentage? | 100 |
| b. Blended (traditional and online) | | percentage? | |
| c. E-learning | | percentage? | |
| d. Correspondence | | percentage? | |
| f. Other | | percentage? | |

Comments:

## B Objectives

1. The main objective of this course

This course introduces evolutionary techniques to the students.

2. Describe briefly any plans for developing and improving the course that are being implemented. (e.g. increased use of the IT or online reference material, changes in content as a result of new research in the field)

The contents will be prepared from globally recognized text books, web-based reference materials and latest research in the field. Practical home works and a term project related to latest tools and techniques will also be designed. At the end of the course, a seminar day can be announced in which students can present their course projects and literature review.

## C. Course Description (Note: General description in the form used in the program's bulletin or handbook)

**Course Description:**

Evolutionary Computation can be considered as a sub-field of Artificial Intelligence. Evolutionary algorithms use Nature as a metaphor and are inspired in the principles of natural selection and genetics. These algorithms have been applied successfully for solving difficult problems across a broad spectrum of fields, including engineering, economics and finance, architecture, design, automatic programming, art generation, and many others. In this course, you will learn the basic working principles of these algorithms.

**1. Topics to be Covered**

| List of Topics | No. of Weeks | Contact hours |
|---|---|---|
| What is Evolutionary Computation? Historical perspective. Major classes of Evolutionary Algorithms. Local vs global search methods. | 1 | 3 |
| Simple genetic algorithms. Major methods for selection, recombination, mutation, and replacement. Representations and design of operators. | 2 | 6 |
| Evolution strategies. The 1/5 rule. Self-adaptation of mutation step sizes. | 1 | 3 |
| Representations. Design of operators. Using problem specific information. | 1 | 3 |
| Genetic programming. | 2 | 6 |
| Interactive Evolutionary Computation. | 1 | 3 |
| Constraint handling. Finding multiple optima. Multi-objective optimization. | 2 | 6 |
| Basic GA theory. Limitations of simple EAs. Problem difficulty and the NFL theorem. | 1 | 3 |

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|---|---|---|
| Goldberg's decomposition for competent GAs. | 1 | 3 |
| Parameter setting in EAs. Performance assessment. | 1 | 3 |
| Basic ideas of Model-based EAs. | 1 | 3 |

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

| | | Lecture | Tutorial | Laboratory/ Studio | Practical | Other | Total |
|---|---|---|---|---|---|---|---|
| Contact Hours | Planned | 42 | | | | | 42 |
| | Actual | 42 | | | | | 42 |
| Credit | Planned | 3 | | | | | 3 |
| | Actual | 3 | | | | | 3 |

**3. Individual study/learning hours expected for students per week.** 9-12

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

**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 targeted learning outcomes. **Third**, insert appropriate assessment methods that accurately measure and evaluate the learning outcome. Each course learning outcomes, assessment method, and teaching strategy should fit in together with the rest to form an integrated learning and teaching process. (Courses are not required to include learning outcomes from each domain.)

**Curriculum Map**

| Code # | NQF Learning Domains And Course Learning Outcomes | Course Teaching Strategies | Course Assessment Methods |
|---|---|---|---|
| **1.0** | **Knowledge** | | |
| 1.1 | Recognize Evolutionary Computations (EC), simple Genetic Algorithms (SGA) and Evolutionary Strategies (ES) | Lecture, Group discussion | Exams, Homework, Quizzes |
| 1.2 | Recognize Representations, Operators, Genetic Programming (GP) and Interactive EC | Lecture, Group discussion | Exam, Homework, Quizzes |
| 1.3 | Understand constraint handling, single/multi-objective optimization | Lecture, Group discussion | Exam, Homework, Quizzes |
| 1.4 | Conceptual understanding of GA theories, issues and assessments | Lecture, Group discussion | Exam, Homework, Quizzes |
| **2.0** | **Cognitive Skills** | | |

| | | | |
|---|---|---|---|
| 2.1 | Design and implement an evolutionary algorithm-based system, process, component or program to meet desired needs. | Lecture, Case studies, research activities, Group discussion | Exams, Reports, Project |
| 2.2 | Investigate real world problems in the context of Evolutionary Computation and design innovative solutions | Lecture, Case studies, research activities, Group discussion | Exams, Reports, Project |
| **3.0** | **Interpersonal Skills & Responsibility** | | |
| 3.1 | Demonstrate own learning and professional development | Small group discussion, research activities, Projects | Project Report, Group presentation |
| 3.2 | Work effectively in groups to accomplish a common goal and show leadership qualities | Small group discussion, research activities, Projects | Project Report, Group presentation |
| 3.3 | Act ethically and responsibly with high moral standards | Small group discussion, research activities, Projects | Anti-plagiarism software's, Project Report, Group presentations |
| **4.0** | **Communication, Information Technology, Numerical** | | |
| 4.1 | Ability to communicate clearly in oral and written form with range of audiences | Project research activities, Project | Project Report, Group presentation |
| **5.0** | **Psychomotor (if any)** | | |
| 5.1 | | | |

**5. Assessment Task Schedule for Students During the Semester**

| | Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.) | Week Due | Proportion of Total Assessment |
|---|---|---|---|
| 1 | Quiz 1 | 2 | 3.3% |
| 2 | Homework 1 | 3 | 3.3% |
| 3 | Quiz 2 | 4 | 3.3% |
| 4 | Homework 2 | 5 | 3.3% |
| 5 | Midterm Exam | 8 | 20% |
| 6 | Quiz 3 | 10 | 3.3% |
| 7 | Homework 3 | 11 | 3.3% |
| 8 | Project | 13 | 30% |
| 9 | Final Exam | 15 | 30% |

## D. Student Academic Counseling and Support

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| 1. Arrangements for availability of faculty and teaching staff for individual student consultations and academic counseling. (include the time teaching staff are expected to be available per week)<br>i. Office Hours for student counseling and support – Three hours/week<br>ii. Availability of teaching Staff on e-learning resources like uqu20/Piazza |

## E Learning Resources

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| 1. List Required Textbooks<br>i. A.E. Eiben, J.E. Smith, Introduction to Evolutionary Computing (Natural Computing Series) Springer; latest edition.<br>ii. Kenneth A. De Jong, Evolutionary Computation: A Unified Approach, MIT Press, latest edition.<br>iii. Riccardo Poli, William B. Langdon, Nicholas Freitag McPhee, A Field Guide to Genetic Programming, Lulu Enterprises, latest edition. |
| 2. List Essential References Materials (Journals, Reports, etc.)<br>i. Recent Papers in Evolutionary Computation related journals |
| 3. List Electronic Materials, Web Sites, Facebook, Twitter, etc.<br>ii. |
| 4. Other learning material such as computer-based programs/CD, professional standards or regulations and software.<br>i. MATLAB, Python, or similar software |

## F. Facilities Required

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| 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.)<br>i. One classroom (25 seats)<br>ii. One lab (25 PCs) |
| 2. Technology resources (AV, data show, Smart Board, software, etc.)<br>i. Whiteboard<br>ii. Internet connection<br>iii. Anti-plagiarism software |
| 3. Other resources (specify, e.g. if specific laboratory equipment is required, list requirements or attach list) |

## G Course Evaluation and Improvement Procedures

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| 1. Strategies for Obtaining Student's Feedback on Effectiveness of Teaching |

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| i. At the end of semester, course evaluation forms will be filled by the students electronically or on paper. The evaluation forms will be anonymous. |
| 2. Other Strategies for Evaluation of Teaching by the Instructor or the Department<br>i. Course file of the course will be maintained and evaluated by some senior faculty member.<br>ii. Instructor evaluation is performed for every semester |
| 3. Procedures for Teaching Development<br>i. Constant reading of new books and research papers, attending related conferences and workshops, participation in the research groups and blogs etc. |
| 4. Procedures for Verifying Standards of Student's Achievement (e.g. check marking by an independent member teaching staff of a sample of student's work, periodic exchange and remarking of tests or a sample of assignments with staff members at another institution)<br>i. A random sample from the marked papers may be evaluated by an independent senior faculty member.<br>ii. Departmental quality assurance committee can review the students grades and course files to make sure that high standard of teaching is maintained. |
| 5. Describe the planning arrangements for periodically reviewing course effectiveness and planning for developing it.<br>i. Department has curriculum committee that periodically review courses.<br>ii. Faculty council review offer program as per need. |

**Name of Course Instructor:** Dr. Mohsin Bilal

**Signature:** *Mohsin Bilal* **Date Completed:** Oct. 22, 2018

**Program Coordinator:** _____

**Signature:** _____ **Date Received:** _____