**COURSE SPECIFICATION**

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| This Course Specification provides a concise summary of the main features of the course and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if he/she takes full advantage of the learning opportunities that are provided. It should be cross-referenced with the program specification. |

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| College of Engineering/ University of Baghdad | 1. Teaching Institution |
| Chemical Engineering | 2. University Department/Centre |
| Applied Numerical Methods | 3. Course title/code |
| Microsoft Excel | 4. Program (s) to which it contributes |
| Annual | 5. Modes of Attendance offered |
| 1st & 2nd / Academic Year 2017 – 2018 | 6. Semester/Year |
| 128 hrs. / 4 hrs. per week | 7. Number of hours tuition (total) |
| October 2017 | 8. Date of production/revision of this specification |
| 9. Aims of the Course | |
| The objective of the course is to be able to use Numerical methods in solving engineering problems and comparing with Analytical methods and apply these methods on Chemical Engineering problems (Mass, Heat, and Momentum transfer) and also to be able to use the spreadsheets of Microsoft EXCEL to solve these problems. | |
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| 10· Learning Outcomes   * Understand and use of the close and open methods used in root finding. * Get Ability to formulate set of linear equations and solving them by different methods and techniques. * Formulate and solve via Newton methods a non-linear set of equation. * Understand and formulate the difference equations and obtain the complementary function and particular integral for them. * Interpolate and extrapolate tabulated data (equal and un-equal interval data) by different techniques. * Understand the numerical differentiation, finding maxima and minima from tabulated data and integration. * Formulate and solve ordinary differential equations (IVP and BVP) via different techniques and methods. * Understand the different forms of the partial differential equations and get an ability to solve them. * Mathematical understanding of the optimization and optimization techniques, optimization dimensions, constrains and curves fitting) |
| **Teaching and Learning Methods** |
| 1. The course consists of Two Halves. Both halves consist of 2 hour per week class lecture and a 2 hour computer Lab. 2. Each class will commence with a recap of the previous lecture, 15-20 minutes for quiz and/or homework discussion, questions will be asked and the responses will be used to evaluate the students’ understanding of the topics covered. 3. The first half subjects are mainly on Numerical methods with Chemical Engineering (Mass, Heat, Fluid, Reactor design and Thermodynamics) applications. The 2nd half subjects are on both Numerical methods and Optimization with Chemical Engineering application. 4. Exam is taken at the end of each general subject. Computer Lab. Exam is taken at the end of each halves. 5. A computer Lab. Final Exam is taken on subjects of both Halves. |
| **Assessment methods** |
| 1. Homework: There will be a minimum of twenty sets of homework during the academic semester. The homework will count 5 % of the total course grade. 2. Quizzes: There will be minimum two closed books and notes quizzes during each academic course. The quizzes will count 5% of the total course grade. 3. Exams: There will be four closed books and notes exams during the academic year. The four exams will count 20% of the total course grade. 4. Laboratory: Lab. work and two Lab. exams will count 10%. 5. Final Exam: The final exam will be Lab. exam (will count 10%) follow by (in different day) comprehensive exam (closed books and notes) that count 50%. The final exam will count 60% of the total course grade. |

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| ***11. Course Structure*** | | | |
| Notes | Laboratory Work | Theoretical Content | Week |
|  | Microsoft-EXCEL | Introduction to Applied Numerical Methods and Error estimation | 1 |
|  | Microsoft-EXCEL | Roots of equations: Fixed point iteration, Xi+1= g( Xi )) | 2 |
|  | Microsoft-EXCEL | Newton-Raphson / Bisection / False-Position | 3 |
| General exam. +Lab. exam. | Microsoft-EXCEL | Applications on finding of roots | 4 |
|  | Microsoft-EXCEL | Matrix operating rules (definition, forms and operations) | 5 |
|  | Microsoft-EXCEL | Solving sets of linear equations: Cramer’s rule / Matrix methods | 6 |
|  | Microsoft-EXCEL | Jacobi / Gauss-Siedel Iterations, Elimination methods | 7 |
|  | Microsoft-EXCEL | Applications to linear equations | 8 |
| General exam. +Lab. exam. | Microsoft-EXCEL | Solving sets of non-linear equations: (Newtons’ method) | 9 |
|  | Microsoft-EXCEL | Finite difference (definition, operations and relations between operators), Difference equations (definitions, degree and order) | 10 |
|  | Microsoft-EXCEL | Solution of difference equation (definition, complementary function and particular integral) | 11 |
|  | Microsoft-EXCEL | Interpolation and extrapolation (introduction and definitions): Lagrangian polynomials. | 12 |
|  | Microsoft-EXCEL | Interpolation with equal intervals (Gregory-Newton forward and backward formulas) with application | 13 |
|  | Microsoft-EXCEL | Interpolation with un- equal intervals (Lagrangian polynomials divided difference formula) with application | 14 |
|  | Microsoft-EXCEL | Numerical Differentiation and integration (introduction): differentiation forward and backward folrumals with application | 15 |
| General exam. +Lab. exam. | Microsoft-EXCEL | Integration (trapezoidal, Simpson 1/3, Simpson 3/8 and Weddle’s) with application | 16 |
|  | Microsoft-EXCEL | Solution of ordinary differential equations (ODE): Initial value problem (Maclarian and Taylor series) with application. | 17 |
|  | Microsoft-EXCEL | Taylor’s series for simultaneous first order ODE, Taylor ‘s series for 2nd order ODE with application | 18 |
|  | Microsoft-EXCEL | Euler’s method (general, Improved and modified Euler formula) with application | 19 |
|  | Microsoft-EXCEL | Range-Kutta method (2nd, 3rd, and 4th order) with application | 20 |
|  | Microsoft-EXCEL | Range-Kutta for simultaneous 1st order ODE and for 2nd order ODE with application | 21 |
|  | Microsoft-EXCEL | Finite difference method for solution of ODE (definitions): central difference approximation expressions (1st, 2nd, ….ect.) | 22 |
| General exam. +Lab. exam. | Microsoft-EXCEL | Applications to ODE | 23 |
|  | Microsoft-EXCEL | Solution of partial differential equations (PDE): introduction, definition and classification | 24 |
|  | Microsoft-EXCEL | Elliptic PDE (Laplace and Poisson’s PDE) with application | 25 |
|  | Microsoft-EXCEL | Parabolic PDE (Bender-Schmidt and Crank-Nicholson methods) with application | 26 |
| General exam. +Lab. exam. | Microsoft-EXCEL | Hyperbolic PDF with application | 27 |
|  | Microsoft-EXCEL | Optimization (introduction and definitions): Newton search | 28 |
|  | Microsoft-EXCEL | Elimination methods (bisecting search, golden ratio search and Fibbonatci’s search) with application | 29 |
|  | Microsoft-EXCEL | Multi-dimensional optimization: direct method (random and grid search) and indirect method (Newton search) with application | 30 |
|  | Microsoft-EXCEL | Constrained optimization: linear programming (simplex) and non-linear programming (generalized reduced gradient search) | 31 |
| General exam. +Lab. exam. | Microsoft-EXCEL | Application to optimization | 32 |

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| 12. Infrastructure | |
| **References**   1. Davis M. E., “Numerical methods and modeling for chemical engineers”, John Wiley and Sons, Inc. 2001. 2. BEERS, K. J ., “Numerical Methods for Chemical Engineering Applications in MATLAB® “,Cambridge University Press, 2007. 3. Curtis F. Gerald, Patrick O. Wheatly, “APPLIED NUMERICAL ANALYSIS” 4th edition, ADDISON-WESLEY PUBLISHING COMPANY 1989. 4. David C. Kuncicky, “INTRODUCTION TO EXCEL” 2nd edition, Prentice-Hall, Inc. 2001.   **Others**   1. Notebook prepared by the instructor of the course. 2. Collection of tutorial sheets of solved and unsolved problems and Exams questions | Required reading:  · CORE TEXTS  · COURSE MATERIALS  · OTHER |
| Computer Lab. | Special requirements (include for example workshops, periodicals, IT software, websites) |
| Special problems | Community-based facilities  (include for example, guest  Lectures , internship , field studies) |

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| 13. Admissions | |
|  | Pre-requisites |
| 20 | Minimum number of students |
| 75 | Maximum number of students |