**HEA (A)-01[a]**

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|  | **BORANG PENAWARAN KURSUS BAHARU /*****New Course Offerings Form*** |

**Nota :**

**Borang Penawaran Kursus Baharu Bagi Program Kejuruteraan/** *New Course Offerings Form for Engineering Program.*

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| **Nama Pusat Pengajian/Fakulti/Pusat/Institut** : | | PPK Mekatronik | |
| (1) **Kod Kursus/** *Course Code* : | ENT442 | | |
| (2) **Tajuk Kursus**/ *Course Title* : | Bahasa Melayu | | Pengenalan Kepada Pengiraan Dinamik Bendalir |
| *English* | | *Introduction to Computational Fluid Dynamics* |
| (3) **Nilai Unit**/ *Number of Unit*  : | 3 | | |
| (4) **Jenis Kursus**/ *Course Type* : | Elektif / *Elective* | | |
| (5) **Prasyarat**/ *Prerequisite* | - | | |
| (6) **Sinopsis Kursus**/ *Course Synopsis*  The course offers an in-depth introductory foundational and technical knowledge in computational fluid dynamics. Starting from the basic fluid dynamics physics, the course will discuss the basic partial differential equation models up to how to implement finite difference and finite volume method for the model equations. Implementation of algorithm for incompressible Navier-Stokes equations will be discussed. Basic grid generation method will also be introduced. The final part of the course will introduce turbulence modeling. | | | |
| (7) **Senarai eksperimen**/ *List of experiments*:  Laboratory 1 : Programming finite difference/finite volume method in Python.  Laboratory 2 : Two-, Three-dimensional flow analysis using ANSYS software. | | | |
| (8) **Pendekatan pembelajaran**/ *Learning approach*:  (i) Lecture : 35 hours  (ii) Laboratory : 8 hours  (iii)Tutorial : 6 hours | | | |
| (9) **Kali pertama penawaran kursus**/ *First time course offered****:***    Semester 1, Academic Session 2019/2020 | | | |

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| (10) **Matriks Hasil Pembelajaran/***Course Outcome Matrix*   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Penyataan CO** | **Taxonomy Level** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **Possible assessment** | | **CO1:**  Ability to analyze and apply basic fluid dynamics related partial differential equations. | C4 | √ | √ | - | - | - | - | - | - | - | - | - | - | Assignment, Quiz, Examination | | **CO2:**  Ability to formulate and apply basic finite difference/finite volume method for fluid dynamics related partial differential equations. | C6 | √ | √ | - | - | - | - | - | - | - | - | - | - | Assignment, Quiz, Examination | | **CO3:**  Ability to solve fluid dynamics related problems by using commercial CFD software and writing codes. | P4 | - | - | - | - | √ | - | - | - | - | - | - | - | Laboratory report, Assignment |   Note : √ certain CO is relevant to that PO |

(11) **Panduan Rancangan Mengajar**/*Teaching Plan Guide :*

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| **StudyWeek** | **Course Content** | **Delivery Mode** | **Level of**  **Complexity** | **Possible**  **Assessment** |
| **1** | **Introduction**  Review of mathematical preliminaries. Basic physics in fluid dynamics. Types of partial differential equations related to fluid dynamics.  **(3 hours)** | Lecture | **C4: Analysis** | Assignment, Quiz, Exam |
| **2-3** | **The Basic Equations of Fluid Dynamics**  Fundamental partial differential equations in fluid dynamics. Compressible and incompressible flow equations. Introduction to Navier-Stokes equations and Euler equations.  **(5 hours)** | Lecture | **C4: Analysis** | Assignment, Quiz |
| **Tutorial 1** (Week 3)  **(2 hours)** | Prob. Solving | **C4: Analysis** |  |
| **4-7** | **Finite Difference Method**  Introduction to finite difference scheme for model partial differential equations. Taylor’s series and polynomials approximation. Finite difference scheme for 1D and 2D problems. Discretization order and error. Consistency, convergence and stability of finite difference scheme. Introduction to Python programming language.  **(9 hours)** | Lecture | **C6: Creating** | Assignment, Quiz, Exam |
| **Quiz 1** (Week 3) | Prob. Solving | **C6: Evaluation** | Quiz |
| **Assignment 1** (Week 4) | Prob. Solving | **C6: Evaluation** | Assignment |
| **Laboratory 1** (Week 5)  **(2 hours)** | Programming | **P4: Mechanism** | Report, Test |
| **Laboratory 1 (cont.)** (Week 6)  **(2 hours)** | Programming | **P4: Mechanism** | Report, Test |
| **Tutorial 2** (Week 7)  **(2 hours)** | Prob. Solving |  |  |
| **Mid-Term Examination** (Week 7) | Examination | **C6: Evaluation** | Examination |
| **8-9** | **Finite Volume Method**  Introduction to finite volume method for model partial differential equations. Application in 1D and 2D problems. Flux interpolation schemes. Numerical integration method. Introduction to commercial CFD software.  **(4 hours)** | Lecture | **C6: Creating** | Assignment, Quiz, Exam |
| **Laboratory 2**(Week 8)  **(2 hours)** | Computer simulation | **P4: Mechanism** | Report |
| **Laboratory 2 (cont.)** (Week 9)  **(2 hours)** | Computer simulation | **P4: Mechanism** | Report |
| **10-11** | **Numerical method for compressible and incompressible flows**  Introduction to compressible Euler equations. Analytical and solution examples to 1D flows. Pressure-correction algorithm for incompressible Navier-Stokes equations.  **(5 hours)** | Lecture | **C4: Analysis** | Assignment, Quiz, Exam |
| **Assignment 2** (Week 10) | Prob. Solving | **C6: Evaluation** | Assignment |
| **11-12** | **Grid generation**  Introduction to structured grid generation. Grid topologies (O-, C- and H-). Metric and Jacobians computation. Relation to finite difference and finite volume method.  **(5 hours)** | Lecture | **C6: Evaluation** | Assignment, Quiz, Exam |
| **Tutorial 3** (Week 12)  **(2 hours)** | Prob. Solving |  |  |
| **13-14** | **Introduction to turbulence**  Features of turbulent flows. Turbulence modeling (k-epsilon, Baldwin-Lomax etc) and its application.  **(4 hours)** | Lecture | **C6: Evaluation** | Assignment, Quiz, Exam |
| **Tutorial 4** (Week 14)  **(2 hours)** | Prob. Solving |  |  |
| **15** | **MINGGU ULANGKAJI** / *REVISION WEEK* | | | |
| **16-17** | **PEPERIKSAAN AKHIR SEMESTER** / *FINAL EXAMINATION* | | | |

**Projek Untuk Pembelajaran Berasaskan Masalah (PBL) – *jika berkenaan*** */*

*Problem-based learning (PBL) projects – where relevant*

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| **Bil.** | **Projek/***Projects* |
|  | NIL |

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| (12) **Sumbangan Penilaian**/ *Evaluation contribution****:***   1. **Peperiksaan***/ Examination:* 70 %  * Peperiksaan Pertengahan Semester/*Mid Term Examinations* = 10 % * Peperiksaan Akhir/ *Final Examination* = 60 %   (ii) **Penilaian Berterusan**/Continual Assessment: 30 %   * Kuiz /*Quizzes* * Tugasan/*Assignment* * Laporan Amali/*Lab Reports* |
| (13) **Tenaga pengajar untuk kali pertama penawaran kursus**/ *Teaching staff during the first time course   offered:*  Dr. Muhammad Izham bin Ismail  En. Mohd Asrul Md Saad |
| (14) **Jumlah pelajar yang dijangkakan untuk kali pertama penawaran kursus**/ N*umber of students*  *expected during the first time course offered****:***    40 pelajar/students |
| (15) **Senarai rujukan**/ *List of references :*  *(*Dahulukan dengan rujukan yang utama/ *list main texts/references first*) :   1. John C. Tannehill, Dale A. Anderson, Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, 2nd Ed. , Taylor and Francis, 1997. 2. John D. Anderson Jr. , Computational Fluid Dynamics: The Basic with Applications, McGraw-Hill, 1995. 3. H. K. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Prentice-Hall, 2007. 4. Oleg Zikanov, Essential Computational Fluid Dynamics, John Wiley, 2010. 5. F. Magoulès, Computational Fluid Dynamics, Chapman and Hall, 2011. |
| (16) **Nota**/ *Notes*  Nil |

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| **(17) DISEDIAKAN OLEH /** *Prepared by* |
| **PENYELARAS**/ Coordinator    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  **Tandatangan dan Cop Rasmi/****Tarikh/***Date*  *Signature and Stamp* |
| **(18) SEMAKAN OLEH /** *Review by* |
| 1. **PENGERUSI RANCANGAN** / *Program Chairman*   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_      \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  **Tandatangan dan Cop Rasmi**/ **Tarikh**/Date  *Signature and Stamp* |
| 1. **PENOLONG PENDAFTAR** / *Assistant Registrar*     \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  **Tandatangan dan Cop Rasmi**/ **Tarikh**/Date  *Signature and Stamp* |
| **(19) PERAKUAN DEKAN/PENGARAH** / *Certification by Dean/Director* |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_      \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  **Tandatangan dan Cop Rasmi**/ **Tarikh**/Date  *Signature and Stamp* |
| **(20) KELULUSAN DEKAN PENGURUSAN AKADEMIK** / *Approval by Dean for Academic Management* |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_      \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Tandatangan dan Cop Rasmi/ **Tarikh**/Date  *Signature and Stamp* |