HEA – 01

UNIVERSITI MALAYSIA PERLIS

BORANG PENAWARAN KURSUS BARU

Pusat Pengajian/Pusat : Pusat Pengajian Kejuruteraan Mekatronik

(1) **Kod kursus/** *Course code*: ENT 342
(2) **Tajuk kursus/** *Course title*: Pengiraan Dinamik Bendalir / Computational Fluid Dynamics
(3) **Nilai unit/** *Number of unit*: 3
(4) **Jenis kursus/** *Course type*: Teras / Core
(5) **Prasyarat/** *Prerequisite*: Tiada / Nil
(6) **Sinopsis kursus/** *Course synopsis*: This course offers comprehensive contents about computational fluid dynamics. It introduces to finite difference and finite volume methods in the analysis of linear and nonlinear problems. This course discusses the solution techniques of inviscid incompressible and compressible fluid flow equations, explains different types of grids, and explains the concept of simple turbulence modeling.
(7) **Senarai eksperimen/** *List of experiments*: 1. Pipe flow entrance region at different Reynolds number 2. Flow around a circular cylinder at different Reynolds number
(8) **Pendekatan pembelajaran/** *Learning approach*: *(sbg. contoh – kuliah, seminar, amali, lawatan, tutorial, dll. Sila nyatakan sekali bilangan jam)* (i) Lecture: 36 hours (86 %) (ii) Tutorial: 6 hours (7 %) (iii)Laboratory: 6 hours (7 %)
(9) **Kali pertama penawaran kursus/** *First time course offered:* Semester 2, Academic session 2012/2013

(10) Matriks Hasil Pembelajaran/Course Outcome Matrix

Course Outcome (CO)	Domain and taxonomy levels	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Possible Assessment
		C	C CTPS	C CTPS	P	P	EM	ES	EM	TS LS	CS	LL	ES	
CO1: Ability to formulate the basic fluid dynamics equations.	**C5**	√	√	-	-	-	-	-	-	-	-	-	-	Assignment, Quiz, Examination
CO2: Ability to discretize related differential equations using different CFD techniques and solve them.	**C6**	√	√	-	-	-	-	-	-	-	-	-	-	Assignment, Quiz, Examination
CO3: Ability to solve fluid flow/heat transfer problems using CFD software.	**P4**	-	-	-	√	√	-	-	-	-	-	-	-	Laboratory

Note : √ certain CO is relevant to that PO

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

Study Week	Course Content	Delivery Mode	Level of Complexity	Possible Assessment
1	**Introduction and mathematical Preliminaries** Application of CFD in engineering field, Characteristics and types of partial differential equation (PDE), Well-posed, Linear and quasi-linear equations, First-order systems, Conservation-law form problems. **(3 hours)**	Lecture		
2 - 3	**The Basic Equations of Fluid Dynamics** Fundamental principles of fluid mechanics, its governing equations and boundary conditions. Compressible fluid with Navier-Stokes equations. Euler and Navier-Stokes equations boundary conditions. **(5 hours)**	Lecture		
	Tutorial 1 (Week 3) **(2 hours)**	Prob. Solving		
4 - 7	**Finite Difference Discretizations** Finite difference spatial discretisation. Derivatives of a fuction by finite difference quotients and Green's theorem. Order of accuracy of discretisation schemes by using Taylor's series. Concepts of consistency, convergence and stability of difference schemes. Equation of parabolic type, hyperbolic type, elliptic type and mixed elliptic-hyperbolic type. **(9 hours)**	Lecture		
	Quiz 1 (Week 4)	Prob. Solving	**C6: Evaluation**	Quiz
	Assignment 1 (Week 5)	Prob. Solving	**C6: Evaluation**	Assignment
	Laboratory 1 (Week 5) **(2 hours)**	Laboratory	**P4 : Mechanism**	Laboratory
	Tutorial 2 (Week 6) **(2 hours)**	Prob. Solving		
	Laboratory 1 Contd. (Week 7) **(2 hours)**	Laboratory	**P4 : Mechanism**	Laboratory
	Mid Term Examination (Week 7)	Examination	**C6: Evaluation**	Examination
8 - 9	**Finite Volume Discretizations** Introduction to finite volume discretization, finite volume discretization for one and two dimensional diffusion problems as well as convection diffusion problems with different differencing schemes. **(5 hours)**	Lecture		
	Assignment 2 (Week 9)	Prob. Solving	**C4: Analysis**	Assignment
	Laboratory 2 (Week 9) **(2 hours)**	Laboratory	**P4 : Mechanism**	Laboratory
10-11	**Solution Algorithms for Pressure-Velocity Coupling in Steady Flows** Introduction to solution requirement for pressure-velocity coupling equations, the staggered grid, the momentum equations, the SIMPLE algorithm and its improvements **(6 hours)**			
12 - 13	**Grids with Approximate Transformations** Introduction to grid generation, types of grids, general transformation of the equations, metrics and Jacobians, stretched grids, boundary fitted grids. **(6 hours)**	Lecture		
	Quiz 2 (Week 12)	Prob. Solving	**C4: Analysis**	Quiz
13 - 14	**Turbulence Modeling** Important features of turbulent flows, length and time scales, statistical representation of turbulent flows, RANS equation, closure problems in turbulence, different types of turbulence model. **(2 hours)**	Lecture		

	Tutorial 3 (Week 13) **(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

Bil.	Projek
	Nil

(12) **Sumbangan penilaian/** *Evaluation contribution:*

(i) **Peperiksaan/** Examination: **70%**
- **Mid Term Examination** **=10%**
- **Final Examination** **= 60%**

(ii) **Penilaian Berterusan/**Continual Assessment: **30%**
- **Assignments**
- **Quizzes**
- **Laboratory**

(13) **Tenaga pengajar untuk kali pertama penawaran kursus/** *Teaching staff during the first time course offered:*

Pensyarah / Lecturers
Prof. Dr. Ghulam Abdul Quadir
Mr. Muhammad Izham Bin ismail

Jurutera Pengajar / Teaching Engineer
Mr. Mohd Asrul Md Saad

(14) **Jumlah pelajar yang dijangkakan untuk kali pertama penawaran kursus/** *Number of students expected during the first time course offered:* ***100 students***

(15) **Senarai rujukan/** *List of references* **:** (Dahulukan dengan rujukan yang utama/ *list main texts/references first*)

1. Pradip Niyogi, S.K. Chakrabartty and M.K. Laha, " Introduction to Computational Fluid Dynamics", Pearson, 2005
2. *Versteeg, Versteeg, Malalasekra & Malalasekra, "An introduction to Computational Fluid Dynamics: The Finite Volume Method" 2nd Ed., Pearson, 2007*
3. *Oleg Zikanov, "Essential Computational Fluid Dynamics", John Wiley, 2010*
4. *H.K. Versteeg and W. Malalasekera, "An introduction to Computational Fluid Dynamics: The Finite Volume Method" 2nd Ed., Longman Scientific & Technical, 1996*
5. *John D. Anderson, Jr., Computational Fluid Dynamics: The Basics with Applications, McGraw-Hill International editions, 1995*
6. *Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu," Computational fluid dynamics: a practical approach" Amsterdam : Butterworth-Heinemann, 2008*

(16) **Nota/** *Notes* (Catatkan di sini maklumat lain yang berkenaan mengenai kursus ini, sekiranya ada)

NIL

(17) **Tandatangan & Kelulusan**/ *Signatures & approvals*

(Pencetus)

Nama: Prof. Dr. Ghulam Abdul Quadir
Tarikh :

(Penolong Pendaftar
Pusat Pengajian/Pusat)

Cik Farah Marzuliana Bt. Mat
Tarikh: 9/9/13.
Cop Rasmi:

FARAH MARZULIANA BT MAT
Penolong Pendaftar
Pusat Pengajian Kejuruteraan Mekatronik
Universiti Malaysia Perlis (UniMAP)

(Dekan/Pengarah)

Prof. Dr. Abdul Hamid Adom
Tarikh : 9/9/2013
Cop Rasmi:

PROF. DR. ABDUL HAMID ADOM
Dekan
Pusat Pengajian Kejuruteraan Mekatronik
Universiti Malaysia Perlis (UniMAP)
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25/9/13
PROF. IR. DR. REZUWAN KAMARUDDIN
Dekan Pengurusan Akademik
Universiti Malaysia Perlis

(Dekan Pengurusan Akademik)
Tarikh :
Cop Rasmi:

COURSE DELIVERY PLAN

ENT 342/3
Computational Fluid Dynamics

2015/16 Session
Semester 2

Class Schedule:

Monday (2.00pm –4.00pm): BKN 2&3

Friday (3.30pm – 4.30pm): BKN 2&3

Laboratory / Tutorial Schedule:

Group 1
Mon (4.00pm –6.00pm): MN4D0

Group 2
Thursday (2.00pm – 4.00pm): MN4D0

Group 3
Wednesday (2.00pm – 4.00pm): MN4D0

Group 4
Tuesday (8.00am – 10.00am): MN4D0

Number of student: 107

Lecturer:

Prof. Dr. Ghulam Abdul Quadir
Professor Room 08, School of Mechatronic Engineering, UniMAP
Email: gaquadir@unimap.edu.my
Phone No.: 012-4266501

Teaching Engineer:
Mohd. Asrul

Technician :

Synopsis :

This course offers comprehensive contents about computational fluid dynamics. It introduces to finite difference and finite volume methods in the analysis of linear and nonlinear problems. This course discusses inviscid incompressible and compressible fluid flow governed by Euler equations and also incompressible and compressible viscous flows governed by boundary layer and Navier-Stokes equations and explain the concept of simple turbulence modeling.

Course Materials :

References:

1. Pradip Niyogi, S.K. Chakrabartty and M.K. Laha, " Introduction to Computational Fluid Dynamics", Pearson, 2005
2. *Versteeg, Versteeg, Malalasekra & Malalasekra, "An introduction to Computational Fluid Dynamics: The Finite Volume Method" 2nd Ed., Pearson, 2007*
3. *Oleg Zikanov, "Essential Computational Fluid Dynamics", John Wiley, 2010*
4. *H.K. Versteeg and W. Malalasekera, "An introduction to Computational Fluid Dynamics: The Finite Volume Method" 2nd Ed., Longman Scientific & Technical, 1996*
5. *John D. Anderson, Jr., Computational Fluid Dynamics: The Basics with Applications, McGraw-Hill International editions, 1995*
6. *Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu," Computational fluid dynamics: a practical approach" Amsterdam : Butterworth-Heinemann, 2008*

Assesment :

a) Exam components (70%)
   a. Midterm Exam = 10%
   b. Final Exam = 60%

b) Coursework components (30%)
   a. Quizzes (2 x)
   b. Assignment (2 x)
   c. Lab Report (3 x)

COURSE DELIVERY AND ASSESSMENTS PLAN

Course Outcome, CO	Curriculum		Delivery/Assessments				
	Teaching Plan	Level of Complexity	Examination		Quizzes/ Assignment	Lab Report	Tutorial
			Final	Midterm			
			60%	10%	20%	10%	
CO1: Ability to formulate the basic fluid dynamics equations.	**Introduction and mathematical Preliminaries** Application of CFD in engineering field, Characteristics and types of partial differential equation (PDE), Well-posed, Linear and quasi-linear equations, First-order systems, Conservation-law form problems. **The Basic Equations of Fluid Dynamics** Fundamental principles of fluid mechanics, its governing equations and boundary conditions. Compressible fluid with Navier-Stokes equations. Euler and Navier-Stokes equations boundary conditions. **Turbulence Modeling** Important features of turbulent flows, length and time scales, statistical representation of turbulent flows, RANS equation, closure problems, different types of turbulent model.	C5	QA1 OR QA2	Q1	Quiz 1 Assignment 1	-	T1
CO2: Ability to discretise related differential equations in different CFD techniques.	**Finite Difference Discretisations** Finite difference spatial discretisation. Derivatives of a function by finite difference quotients and Green's theorem. Order of accuracy of discretisation schemes by using Taylor's series. Concepts of consistency, convergence and stability of difference schemes. Equation of parabolic type, hyperbolic type, elliptic type and mixed elliptic-hyperbolic type. **Finite Volume Discretizations** Introduction to finite volume discretization, finite volume discretization for one and two	C6	QB1 QB2 QB3	Q2	Assignment 2 Quiz 2	-	T2 & T3

	dimensional diffusion problems as well as convection diffusion problems with different differencing schemes. **Solution Algorithms for Pressure-Velocity Coupling in steady flows** Introduction to solution requirement for pressure-velocity coupling equations, the staggered grid, the momentum equations, the SIMPLE algorithm and its improvements. **Grids with Approximate Transformations** Introduction to grid generation, Types of grids, general transformation of the equations, metrics and Jacobians, stretched grids, boundary fitted grids.						
CO3: Ability to solve problem using CFD software.	CFD Software applications	P4	-	-		Lab 1 & Lab 2	-

Part A: Answer ANY ONE (2 questions)

Part B: Answer ALL (3 questions)

Week	Chapter	Lecture	Assignment/Quiz	Laboratory/Tutorial
1	**Introduction and mathematical Preliminaries** Application of CFD in engineering field, Characteristics and types of partial differential equation (PDE). Well-posed, Linear and quasi-linear equations, First-order systems, Conservation-law form problems.	3	-	-
2 - 3	**The Basic Equations of Fluid Dynamics** Fundamental principles of fluid mechanics, its governing equations and boundary conditions. Compressible fluid with Navier-	5	-	Tutorial 1 (Week 3)

	Stokes equations. Euler and Navier-Stokes equations boundary conditions.			
4 - 7	**Finite Difference Discretisations** Finite difference spatial discretisation. Derivatives of a function by finite difference quotients and Green's theorem. Order of accuracy of discretisation schemes by using Taylor's series. Concepts of consistency, convergence and stability of difference schemes. Equation of parabolic type, hyperbolic type, elliptic type and mixed elliptic-hyperbolic type.	9	Assignment 1 (Week 5) Quiz 1 (Week 4)	Laboratory 1 (Week 5) Tutorial 2 (Week 6) Laboratory 1 Contd. (Weel 7)
8	**MID SEMESTER BREAK**			
9-10	**Finite Volume Discretizations** Introduction to finite volume discretization, finite volume discretization for one and two dimensional diffusion problems as well as convection diffusion problems with different differencing schemes.	5	Assignment 2 (Week 9)	Laboratory 2 (Week 9)
11-12	**Solution Algorithms for Pressure-Velocity Coupling in steady flows** Introduction to solution requirement for pressure-velocity coupling equations, the staggered grid, the momentum equations, the SIMPLE algorithm and its improvements.	6	-	-
13-14	**Grids with Approximate Transformations** Introduction to grid generation, Types of grids, general transformation of the equations, metrics and Jacobians, stretched grids, boundary fitted grids.	6	-	-
15	**Turbulence Modeling** Important features of turbulent flows, length and time scales, statistical representation of turbulent flows, RANS equation, closure problems, different types of turbulent model.	2	-	Tutorial 3 (Week 13)
16	Revision Week			

UNIVERSITI MALAYSIA PERLIS
SCHOOL OF MECHATRONICS ENGINEERING
NOTIONAL LEARNING TIME CALCULATION

Course Code / Name	ENT 342: Computational Fluid Dynamics	Academic Session & Semester	Session 2015/2016 semester 2
Course Coordinator	Prof. Dr. Ghulam Abdul Quadir	Teaching Engineer	Mohd Asrul
Lecturers	Prof. Dr. Ghulam Abdul Quadir	Technician	

(Independent Hours)/(credit Hours)			Aktiviti Pembelajaran Kendiri		
Component	Multiplying Factor	MQA proposed student independent learning time per 1 component hr	Pembelajaran Tak Bersemuka [Projek, Tugasan, PBL]	Ulangkaji [Syarahan, Tutorial, Amali]	Persediaan Penilaian [Ujian, Peperiksaan]
Lecture	1.33	1-2 hours			
Tutorial	1	1-2 hours or 3 hrs if involving case studies			
Laboratory	0.66	0.66-1 hour			
Assignment	3	10-20 hours per 2000 words			
Presentation	3	3-4 hours			
Quiz	0	Pop quiz - SLT is not required	6	57.84	15
Test	3	3-7 hours			
PBL/Project	8	8-10 hours			
Final Exam	4	3-7 hours		78.84 OK	
Notional Credit Hour/ Credit Hour	40				
Course Credit	3				

Remarks: 40 learning hours per semester is equivalent to 1 credit

Notes on Notional Credits:

Average loading per semester: **4** courses
Average loading per semester: 4 x 4 = **16** credits
Total learning hours (Based on Lecture): 16 + 16 = 32 Hours per Week

Learning Hours for students: 8 hours x 5 Days = 40 Hours (Weekdays)

120 Credit Hours to Graduate
No. of Semester to Graduate: 120/16 = **8** Semesters
No. of Years to Graduate: 8/2 = **4** Years

Week	Topics	Lecture (hr)	Tutorial(hr)	Laboratory(hr)	Assignment(no.)	Presentation (no.)	Quiz(no.)	Test(hr)	PBL/Project(no.)	Final Exam(hr)	Ind. Learning(hr)	Total Learning Hour
1	Introduction and mathematical Preliminaries	3	0	0	0	0	0	0	0		3.99	**6.99**
2-3	The Basic equations of Fluid Dynamics	5	2	0	0	0	0	0	0		8.65	**15.65**
4-7	Finite Difference Discretisations	9	2	4	1	0	1	1	0		22.61	**38.61**
8	**MID SEMESTER BREAK**											
9-10	Finite volume discretization	5	0	2	1	0	0	0	0		10.97	**17.97**
11-12	Solution algorithms for Pressure-velocity coupling in steady flows	6	0	0	0	0	0	0	0		7.98	**13.98**
13-14	Grids with approximate transformations	6	0	0	0	0	1	0	0		7.98	**13.98**
15	Turbulence modeling	2	2	0	0	0	0	0	0		4.66	**8.66**
16												
17	**EXAMINATION WEEK**									3	12	**15**
18												
19												
	Total Learning Hour in 1 Semester	36	6	6	2	0	2	1	0	3	78.84	**130.84**
											Credit	**3.27**

Pembelajaran bersemuka			aktiviti pembelajaran kendiri			penilaian formal		Jumlah JPP
Syarahan	amali/ tutorial	SCL	PTB(assgment/modul)	ulangkaji (seblum class /lab/tutor)	persediaan penilaian (test/final exam)	penilaian berterusan (test/quiz)	peperiksaan akhir	
36	12	0	6	45.96	15	1	3	118.96