

Automation and Computer-Aided Engineering

Course Description

(Unless otherwise specified, all are 3-unit term courses of three hours of lecture and one hour of tutorial per week.)

*ACE 1020

Computer-Aided Drafting and Design

ACE 1030

Basic Electronics

1st term

Linear circuit theory. DC and AC analysis. Circuit models of diodes and BJT transistors. Digital circuits. Op-Amps. Feedback principle. Circuit design using IC's.

ACE 1100

Statics and Dynamics

2nd term

Force and moment vectors. Free-body diagrams. Equations of equilibrium. Friction. Moments of inertia. Kinematics of particles. Newton's second law. Energy and momentum methods of particles. Kinematics of rigid bodies. Dynamics of rigid bodies. Energy and momentum methods for rigid bodies.

ACE 1880

Engineering Practice

2nd term

This course formally introduces engineering as a profession to the students. The basic topics include: introduction to engineering profession; engineering ethics; laws for engineers; professional engineers registration; environment protection; industrial health and safety; introduction to engineering economics; standards and ISO 9000. Invited lectures given by professional associations in Hong Kong. (Not for students who have taken ELE 2860 or 2880.)

*ACE 2020

Product Design

ACE 2030

Introduction to Control Systems

1st term

Linear approximation of engineering systems. Laplace transform. Transfer function and block diagram representation. Characteristics of feedback systems. Performance specifications. Routh-Hurwitz stability criterion. Root locus design. Frequency response design. Nyquist criterion. Introduction to state space models. Utilization of computer-aided analysis and design software. (Not for students who have taken ELE 2240.)

ACE 2050

Engineering Computer Graphics

1st term

Elements of interactive computer graphics. Mathematical bases and manipulation of curves and surfaces. Introduction to geometric and solid modelling. Display techniques. Applications in industries.

* Courses offered in 2001-02 and before.

ACE 2060

Manufacturing Technology

2nd term

Overview of manufacturing engineering. Engineering materials. Metal forming processes. Machining processes. Plastic injection molding processes. Assembly. Hands-on experiments/projects.

ACE 2070

Fundamentals of Machine Intelligence

2nd term

Data structures, sorting and searching. Knowledge representation: state space; logical statements; rules; connectionism. Discrete problem solving by state space search. Deduction by resolution in predicate logic. Inference by ruled-based systems. Mappings by networks. Principles of learning. Application examples.

ACE 2110

Signal Processing

1st or 2nd term

Overview of signals and systems. Fourier transform. Sampling theorem. The z-transform. Discrete Fourier transform. Introduction to analysis and design of filters.

ACE 2120

Computational Mechanics

1st or 2nd term

Linearelasticity. Loading and deformation. Stress and strain. Constitutive equations. Finite element modelling. Material properties. Shape functions. Boundary conditions. Stress analysis. Implementation of finite element method. Applications in engineering design. Prerequisite: ACE 1100 or its equivalent.

ACE 2800

Laboratory I

2 U; 4 Lab.; 1st term

ACE 2810

Laboratory II

2 U; 4 Lab.; 2nd term

ACE 3010

Modern Control Systems Analysis and Design

1st or 2nd term

Continuous and discrete domain state space representations: transition matrix; stability; controllability and observability; pole placement controller; state estimator. Emulation designs. Discrete design. Case studies.

ACE 3030

Introduction to Robotics

1st or 2nd term

Robot classification and specification. Coordinate frames and homogeneous transformations. Denavit-Hartenberg notation. Forward and inverse kinematics. Differential motion. Jacobians and statics. Singularity. Workspace analysis. Actuators, sensors, and end-effectors. Trajectory generation. Introduction to robot motion planning.

ACE 3040

Computer-Integrated Manufacturing

1st or 2nd term

Concurrent engineering. Computer-integrated-manufacturing models and concepts. Rapid prototyping. Computer-aided-manufacturing. Control of manufacturing systems: numerical control and computer numerical control; programmable logic controller; computer-aided process planning and manufacturing scheduling; quality assurance. Hands-on experiments/projects.

ACE 3050

Computational and Optimization Methods

1st or 2nd term

Numerical solutions to linear and nonlinear equations. Computational linear algebra. Numerical differentiation and integration. Numerical methods for differential equations. Linear and nonlinear programming. Dynamic programming. Prerequisite: ERG 2014 and 2015.

ACE 3100

Machine Vision and Image Processing

1st or 2nd term

Imaging models. Image acquisition. Statistical operations. Spatial operations and transformations. Segmentation and edge detection. Morphological and area operations. Finding 2-D basic shapes. Scene labelling. Introduction to 3-D shape from: stereo, motion, boundary, shading, and texture. Active range sensing. Example applications.

ACE 3120

Geometric Modelling

1st or 2nd term

Curves and surfaces design: de Casteljau algorithm; subdivision; degree elevation; parametric and geometric continuity; intersection, trimming, blending and fillets. Solid modelling: representation schemes; Boolean operations. Parametric and feature-based design.

ACE 3130

Robot Dynamics and Control

1st or 2nd term

Robot dynamics. Position control: computer-torque control; PD-plus-gravity controller; Cartesian space control. Force control: natural and artificial constraints; hybrid position force control; impedance control. Dexterity and redundancy: manipulability measure and ellipsoid; dynamic manipulability; kinematic redundancy; optimal configuration and motion planning.

ACE 3140

Optimal and Robust Control

1st or 2nd term

Constrained optimization. Lagrange multipliers. Linear quadratic regulator for discrete and continuous time systems. Steady-state and suboptimal control. Lyapunov and Riccati equations. Tracking problem. Robustness and multivariable frequency domain analysis. Singular value plots. Introduction to linear quadratic Gaussian and loop-transfer recovery design.

ACE 3160

Simulation and Interface

1st or 2nd term

Human perceptual system. Interface technologies: sensors; input and output devices; protocols; common interface paradigms. Human-machine interaction: teleoperation; force-reflecting systems; haptic interfaces.

ACE 3180

Machine Intelligence and Applications

1st or 2nd term

The emerging technologies of intelligent systems. Topics include neural networks; fuzzy logic; simulated annealing; genetic algorithms; and their applications to control, robotics, automation, manufacturing, and transportation systems.

ACE 3190

Sensors and Actuators

1st or 2nd term

Introduction to instrumentation systems. Measurement fundamentals. Modelling of physical systems. Signal conditioning. Data acquisition. Sensors. Actuators. Interface electronics. Integrated sensors-actuators. Applications in automation.

ACE 3200

Micro and Nano Electro Mechanical Systems

1st or 2nd term

Introduction to MEMS/NEMS devices. Micro/Nano fabrication techniques. MEMS/NEMS design methodology. Materials for MEMS/NEMS. Dominant physical phenomena in the Micro/Nano worlds. Micro/Nano manipulations. Experimental methods for Micro/Nano devices. Applications for MEMS/NEMS.

ACE 3210

Nonlinear Systems and Control

1st or 2nd term

Ordinary differential equation description of nonlinear state space systems. Phase plane analysis. Linearization. Concepts of stability. Lyapunov theory. LaSalle theory. Limit cycles. Feedback linearization. Sliding mode control. Backstepping.

ACE 3220

Smart Materials and Structures

1st or 2nd term

Overview of smart materials technology. Characteristics of smart materials such as piezoelectric materials, magnetorheological fluids, and shape memory alloys. Smart actuators and sensors. Structural modelling and design. Dynamics and control for smart structures. Integrated system analysis. Applications in buildings, industries, and biomedicine.

ACE 3910

Thesis I

3 U; 1st term

The final-year project in the first term of the third year of attendance.

ACE 3920

Thesis II

3 U; 2nd term

The final-year project in the second term of the third year of attendance. Prerequisite: ACE 3910. (Graduation Project as prescribed by ACE 3910/3920 will carry a separate weight of 10% in honours classification in Automation and Computer-Aided Engineering.)

Study Scheme

Major Programme

There are two streams of specialization: Automation and Computer-Aided Engineering. Students have to take the same required courses. They may select certain elective courses as prescribed to specialize in one of the two streams, or arbitrarily select different elective courses not specializing in any of the two streams. A student who does not wish to specialize in any of the two streams should follow the advice of the academic advisers of the Department on choosing the ten elective courses.

A. Applicable to students admitted in 2003-04 and thereafter

Students are required to complete a minimum of 78 units of Major courses as follows (Please see Notes 1-3):

- | | | |
|------|--|----------|
| (i) | Required Courses:
ACE 1030, 1100, 1880, 2030, 2060, 2070, 2800, 2810,
3910, 3920, CSC 1110, ELT 1111, ERG 2014, 2015,
3820 [#] , IDE 1020 and SEG 2470 [#]
Graduation Project as prescribed by ACE 3910/3920
will carry a separate weight of 10% in the assessment
for degree classification. | 48 units |
| (ii) | Ten Elective Courses from Group A, B and C:
Group A: ERG 2020, ACE 2110, 3010, 3030 and 3190
Group B: ACE 2050, 2120, 3160, IDE 2020 [#] and
CSC 2520 [#]
Group C: ACE 3040, 3050, 3100, 3120, 3130, 3140,
3180, 3200, 3210, 3220, CSC 3170 [#] ,
ELE 3230 [#] , 4230 [#] , IDE 2040 [#] , 3020 [#] ,
3030 [#] , IEG 3310 [#] , 4180 [#] , SEG 2440 [#] , 3450 [#] ,
3490 [#] , 3500 [#] and 3530 [#] | 30 units |

Total: 78 units

Plus three weeks of industrial training in the summer after their first year of attendance.

Streams of Specialization

- (a) Automation Stream
Students choosing automation stream should take, among the ten elective courses, five courses from Group A and five courses from Group B and Group C.
- (b) Computer-Aided Engineering Stream
Students choosing computer-aided engineering stream should take, among the ten elective courses, five courses from Group B and five courses from Group A and Group C.

B. Applicable to students admitted in 2001-02 and 2002-03

Students are required to complete a minimum of 78 units of Major courses as follows (Please see Notes 1-3):

- | | | |
|-----|--|----------|
| (i) | Required Courses:
ACE 1030, 1100, 1880, 2030, 2070, 2800, 2810, 3040,
3100, 3910, 3920, CSC 1110, ELT 1111, ERG 2014,
2015, 3820 [#] and SEG 2470 [#] | 48 units |
|-----|--|----------|

Graduation Project as prescribed by ACE 3910/3920 will carry a separate weight of 10% in the assessment for honours classification.

- (ii) Ten Elective Courses from Group A, B and C: 30 units
 Group A: ERG2020, ACE 2110, 3010, 3030 and 3190
 Group B: ACE 2050, 3160, IDE 1020 (or ACE 1020^A), 2020[#] and CSC 2520[#]
 Group C: ACE 2060, 2120, 3050, 3120, 3130, 3140, 3180, 3200, 3210, 3220, CSC 3170[#], ELE 3230[#], 4230[#], IDE 2040[#], 3020[#], 3030[#], IEG 3310[#], 4180[#], SEG 2440[#], 3450[#], 3490[#], 3500[#] and 3530[#]

Total: 78 units

Plus three weeks of industrial training in the summer after their first year of attendance.

Streams of Specialization

- (a) Automation Stream
 Students choosing automation stream should take, among the ten elective courses, five courses from Group A and five courses from Group B and Group C.
- (b) Computer-Aided Engineering Stream
 Students choosing computer-aided engineering stream should take, among the ten elective courses, five courses from Group B and five courses from Group A and Group C.

Recommended Course Pattern (Automation Stream)

I. Applicable to students admitted in 2003-04 and thereafter

Term 1	Units	Term 2	Units	Term 3	Units
General Education	3	General Education	3	General Education	3
Physical Education	1	Physical Education	1	ACE 2030	3
ACE 1030	3	ACE 1100	3	ACE 2800	2
CSC 1110	3	ACE 1880	3	SEG 2470	3
IDE 1020	3	ELT 1111	3	1 Major Elective (Group A):	
ERG 2014	3	ERG 2015	3	ACE 2110	3
1 Major Elective (Group A): ERG 2020	3			1 Major Elective (Group B or C)	3
	—		—		—
	19		16		17
Term 4	Units	Term 5	Units	Term 6	Units
General Education	3	ACE 3910	3	ACE 3920	3
ACE 2060	3	2 Major Electives (Group A):		1 Major Elective (Group A):	
ACE 2070	3	ACE 3010	3	ACE 3190	3
ACE 2810	2	ACE 3030	3	2 Major Electives (Group B or C)	6
ERG 3820	2	1 Major Elective (Group B or C)	3	Free Elective	2
1 Major Elective (Group B or C)	3	Free Elective	3		
Free Elective	2		—		—
	—		—		—
	18		15		14

D Applicable to students admitted in 2001-02.

II. Applicable to students admitted in 2001-02 and 2002-03

Term 1	Units	Term 2	Units	Term 3	Units
General Education	3	General Education	3	General Education	3
Physical Education	1	Physical Education	1	ACE 2030	3
ACE 1030	3	ACE 1100	3	ACE 2800	2
CSC 1110	3	ACE 1880	3	SEG 2470	3
ERG 2014	3	ELT 1111	3	1 Major Elective	
1 Major Elective : (Group A)		ERG 2015	3	(Group A): ACE 2110	3
ERG 2020	3			1 Major Elective (Group B or C)	3
—	—		—		—
	16		16		17
Term 4	Units	Term 5	Units	Term 6	Units
General Education	3	ACE 3910	3	ACE 3040	3
ACE 2070	3	2 Major Electives		ACE 3100	3
ACE 2810	2	(Group A):		ACE 3920	3
ERG 3820	2	ACE 3010	3	1 Major Elective	
1 Major Elective (Group B or C)	3	ACE 3030	3	(Group A): ACE 3190	3
Free Electives	4	2 Major Electives (Group B or C)	6	1 Major Elective (Group B or C)	3
—	—	Free Elective	3		—
	17		18		15

Recommended Course Pattern (Computer-Aided Engineering Stream)**I. Applicable to students admitted in 2003-04 and thereafter**

Term 1	Units	Term 2	Units	Term 3	Units
General Education	3	General Education	3	General Education	3
Physical Education	1	Physical Education	1	ACE 2030	3
ACE 1030	3	ACE 1100	3	ACE 2800	2
CSC 1110	3	ACE 1880	3	SEG 2470	3
ERG 2014	3	ELT 1111	3	2 Major Electives	
IDE 1020	3	ERG 2015	3	(Group B): ACE 2050	3
		1 Major Elective (Group B): CSC 2520	3	ACE 2120	3
—	—		—		—
	16		19		17
Term 4	Units	Term 5	Units	Term 6	Units
General Education	3	ACE 3910	3	ACE 3920	3
ACE 2060	3	1 Major Elective		3 Major Electives (Group A or C)	9
ACE 2070	3	(Group B):		Free Elective	3
ACE 2810	2	ACE 3160	3		
ERG 3820	2	2 Major Electives (Group A or C)	6		
1 Major Elective (Group B): IDE 2020	3	Free Electives	4		
—	—		—		—
	16		16		15

II. Applicable to students admitted in 2001-02 and 2002-03

Term 1	Units	Term 2	Units	Term 3	Units
General Education	3	General Education	3	General Education	3
Physical Education	1	Physical Education	1	ACE 2030	3
ACE 1030	3	ACE 1100	3	ACE 2800	2
CSC 1110	3	ACE 1880	3	SEG 2470	3
ERG 2014	3	ELT 1111	3	1 Major Elective	
1 Major Elective		ERG 2015	3	(Group B):	
(Group B):		1 Major Elective		ACE 2050	3
IDE 1020	3	(Group B):		1 Major Elective	3
	—	CSC 2520	3	(Group A or C)	
	16		19		17
Term 4	Units	Term 5	Units	Term 6	Units
General Education	3	ACE 3910	3	ACE 3040	3
ACE 2070	3	1 Major Elective		ACE 3100	3
ACE 2810	2	(Group B):		ACE 3920	3
ERG 3820	2	ACE 3160	3	1 Major Elective	3
1 Major Elective		2 Major Electives	6	(Group A or C)	
(Group B):		(Group A or C)		Free Elective	3
IDE 2020	3	Free Electives	4		
1 Major Elective	3				
(Group A or C)	—		—		—
	16		16		15

SUMMARY

	Units
General Education	12
Physical Education	2
Major Required Courses	48
Major Electives	30
Free Electives	7
	—
Total	99

- Notes: 1. Major courses coded ACE 2000 and above will be included in the calculation of the Major GPA for honours classification. Courses with “#” are to be included in the Major GPA as well.
2. Number of “free elective” courses to be taken each term may be adjusted as long as the units requirement of the programme for graduation is fulfilled.
3. Students are strongly advised to consult their academic advisers in choosing elective courses.