課程綱要與教學日誌

104 學年度 第 1 學期

課程名稱：（中文）**生理系統分析與建模** http://www.jyhuang.idv.tw/AnalysisOfPhysiologicalSystems.aspx （英文）Analysis and Modeling of Physiological Systems				開課單位	
				永久課號	
授課教師：黃中垚 (T8068)					
學分數	3	必/選修	選	開課年級	大四、研究所
先修科目或先備能力： Applied Mathematics (Compulsive). Physiology at the level of Engineering Sciences (suggested)					
課程概述與目標： This course (生理系統分析與建模) aims to introduce system theory and engineering relevant analytical tools with applications from bioengineering and physiology, including differential equations, linear and nonlinear systems, feedback and stability, the complementary nature of time and frequency domain methods, etc. To encourage students exploring the potential of the analytical techniques introduced, the lecturer also offer some physiology relevant applications in the course, including musculoskeleton properties and dynamics, vestibular system, pupil control system and cardiovascular regulation. Except doing the homework set, following the course some designed numerical laboratory works based on Matlab and Opensim also have to be completed, which aims to cultivate the hand-on experience of the students. The laboratory works may include neural models, feedback control systems, properties of muscle, and cardiovascular function.					
教科書	Lecture notes and papers that are posted in my website.				

課程大綱		分配時數				備註
單元主題	內容綱要	講授	示範	習作	其他[1]	
1. Overview of Physiological Systems	1.1 Abstraction of Engineering Systems 1.2 Static vs Dynamic 1.3 Linearity 1.4 Time-invariant vs. time-varying 1.5 Stability 1.6 An example from Physiology	3				

2. Electrical and Mechanical Systems	2.1 Electrical Systems 2.2 Kirchoff's Voltage and Current Laws 2.3 The Resistor-Inductor Circuit 2.4 The Connection Between Electrical and Mechanical Systems 2.5 A Physiological Example 2.6 The Systems Approach to Mechanical Systems 2.7 Spring-Mass-Damper System and Forced Systems 2.8 A Physiological Example	3				
3. Laplace Transform and Ordinary Differential Equations (ODEs)	3.1 Laplace Transform 3.2 Properties of the Laplace Transform 3.3 Inversion of the Laplace Transform 3.4 Solution of ODEs with the Laplace Transform	3				
4. Transfer Functions	4.1 Definition 4.2 Linearity 4.3 Response to Periodic Inputs 4.4 Block Diagram Manipulation 4.5 Second Order Systems 4.6 The Impulse Response	3				
5. Block Diagrams and Convolution	5.1 Four standard block diagram elements 5.2 Block Algebra Derived Results 5.3 Potential solutions 5.4 Convolution Description	3				
6. Fundamental Muscle Mechanics	6.1 Muscle types: Skeletal, Cardiac, Smooth 6.2 Muscular Contraction: Isometric and Isotonic 6.3 Mechanical Events: Twitch and Tetanus 6.4 Tension-Length Curves: Passive and Active 6.5 Series Elastic Component 6.6 Force-Velocity Curves 6.7 Active State: Muscles Active While Lengthening; Time Course of Active State in a Twitch	3				
7. **Case Study1:** The Prevention of Ankle Inversion Injury	7.1 Explore the musculoskeletal model of ankle, foot, and orthosis 7.2 Evaluate ankle inversion injury during a drop landing on a sloped surface 7.3 Analyze the effects of an ankle–foot orthosis on ankle inversion 7.4 Analyze the effects of muscle co-activation 7.5 Prevent injury with a device and training program	3				

8. Bode Plot and Fourier Series and Transform	8.1 Response to a pure sinusoid 8.2 The Bode Plot 8.3 Bode Plot Elements 8.4 Pole/Zero at the Origin, Real Pole/Zero, Complex Pole/Zero 8.5 Pure Time Delay 8.6 Fourier Series and Fourier Transforms 8.7 Graphical Representations of Fourier Transforms for common signals	3				
9. **Case Study2:** Vestibular System	9.1 Sensation and Perception 9.2 Hair Cells and Otolith Organs 9.3 Directional Sensitivity of the Hair Cell 9.4 Elementary model of vestibular motion sensor 9.5 Semicircular Canals 9.6Response to sinusoidal stimulation and dynamics (the Bode Plot) of peripheral vestibular system	3				
10. Close Loop and Stability	10.1 Closed Loop Systems 10.2 Examples of Feedback Systems 10.3 Block Diagram Manipulation: Stability, Sensitivity, Disturbance Rejection, Steady State Error	3				
11.The Phase Plane and The State Space	11.1 State Space Representations 11.2 The Phase Plane 11.3 Negative Real Roots 11.4 Stability of Linear Systems 11.5 Transfer Function to State Space 11.6 State Space to Transfer Function 11.7 Alternate State Space Representations 11.8 State Space Feedback Controller Design 11.9 State Space Observer Design	6				
12.**Case Study3:** The Pupil Control System	12.1 Information Flow Diagram of The Pupil Control System 12.2 Comparator 12.3 Logarithmic Sensitivity 12.4 Adaptation Dynamics 12.5 Information Content of the Neural Signals 12.6 The Generic Structure of Control Systems	3				
Student Project Presentation: Simulink Model of ECG		6				

1. 教學要點概述 (請填寫教材編選、教學方法、評量方法、教學資源、教學相關配合事項等)：

Students must actively participate the lectures and discussions. The overall performance of a student will be evaluated by two homeworks (40%) and the final project (60%) she or he completes as a team effort. Projects combining experimental data and simulations are particularly encouraged.

教學日誌(進度)

週次	上課日期	課程進度、內容、主題
1-2		See 內容綱要
3-4		
5-6		
7-8		
9-10		
11-12		
13-14		
15-16		
17		**Student Project Presentation Session I**
18		**Student Project Presentation Session II**

備註：

1. 其他欄包含參訪、專題演講等活動。
2. 所有課程包括學系所開設必（選）修、選修課程，以及校際所開設課程，如共同必修科目、通識課程等，皆須填寫此表格。
3. 如需本課程綱要表格之電子檔，請至課務組網頁－＞各類申請表下載。
4. 請用電腦打字成檔案，於每學期末、初選前（1 月初及 6 月初），利用選課系統（http://cos.adm.nctu.edu.tw/）之「課程綱要上傳」將課程綱要 update 上網。