106 年準大學生先修課程聯合認證平台計畫

課程內容

課程設定	
開課學校	國立中正大學
開課系所	物理系
課程名程	普通物理（Ⅰ）
授課教師	包健華
學分數	4 or3
修課學生人數上限	本校學生 ： 35 外校學生 ： 15
授課形式	☑ 實體授課 ☑ 線上課程 □ 其他 _____
上課地點	物理系 107 教室
上課時間	_7_ 月 _3_日 ~ _8_ 月 _31_日 星期 二 : 14:00 ~ 16:00, 星期 三 : 13:00 ~ 17:00,
課程相關事務聯絡窗口	
姓名、職稱	包健華, 教授
電話	052720411 x 66301, 052729137
電子信箱	physicspao@gmail.com
課程資訊	
課程概述	物理一課程包括數學能力、運動學、牛頓力學、圓周運動、能量與動量守恆、轉動慣量與能量、角動量、靜力平衡、流體力學、振動、波動、聲波、熱力學。
課程目標	介紹基本的物理領域範圍的知識, 以物理圖像來解釋物理機制, 藉由微積分、向量分析(向量微積分)與微分方程等數學技巧定量分析物理概念, 融合物理知識在生活層面的應用
課程要求	1. 學生須有高中物理與數學基礎。本課程要求學生自我學習，可從教學影片、教課書、講義及老師面授課互動中學習，除期中期末測驗外，每週的面授課程與學習進度檢測，學生必須參與 80% 以上（含）以取得本課程學分。 2. **修課同學, 第一堂課(7/4)必須出席.**
指定閱讀	Physics for Scientists & Engineers by Giancoli, 4th Edition

評量方式	學期測驗 2 次: 30%, 35%, 作業& 小考：25%

課程大綱（3 學分）			
週次	**日期**	**單元主題**	**備註欄 ：實體授課日期(暫定)**
1	7/2-8	Introduction, basic Calculus (Ch 1 in textbook by Giancoli 4th Ed.), Kinematic: 1D and 2D (Ch 2-3)	2pm-4pm, 7/4 1pm-5pm, 7/5
2	7/9-15	Newton's laws (Ch 4) Newton's law: Applications (Ch 5-6)	2pm-4pm, 7/11 1pm-5pm, 7/12
3	7/16-22	Work and Energy (Ch 7-8), Momentum (Ch 9)	2pm-4pm, 7/18 1pm-5pm, 7/19
4	7/23-29	Rotational Motion (I), (II) (Ch 10-11)	2pm-4pm, 7/25 1pm-5pm, 7/26
5	7/30-8/5	Rotational Motion (II) (Ch 10-11) Midterm (8/2)	2pm-4pm, 8/1 1pm-5pm, 8/2
6	8/6-8/12	Harmonic motion (Ch 14)	2pm-4pm, 8/8 1pm-5pm, 8/9
7	8/13-19	Thermodynamics (I) (Ch 17-20)	2pm-4pm, 8/15 1pm-5pm, 8/16
8	8/20-26	Thermodynamics (II) (Ch 17-20)	2pm-4pm, 8/22 1pm-5pm, 8/23
9	8/27-31	Final Exam	1pm-5pm, 8/29

課程大綱（4 學分）			
週次	日期	單元主題	備註欄 ：實體授課日期(暫定)
1	7/2-8	Introduction, basic Calculus (Ch 1 in textbook by Giancoli 4th Ed.), Kinematic: 1D and 2D (Ch 2-3)	2pm-4pm, 7/4 1pm-5pm, 7/5
2	7/9-15	Newton's laws (Ch 4) Newton's law: Applications (Ch 5-6)	2pm-4pm, 7/11 1pm-5pm, 7/12
3	7/16-22	Work and Energy (Ch 7-8), Momentum (Ch 9)	2pm-4pm, 7/18 1pm-5pm, 7/19
4	7/23-29	Rotational Motion (I), (II) (Ch 10-11)	2pm-4pm, 7/25 1pm-5pm, 7/26
5	7/30-8/5	Rotational Motion (III) (Ch 10-11) Static equilibrium (ch12) & Fluids (Ch 13), Midterm on 8/2	2pm-4pm, 8/1 1pm-5pm, 8/2
6	8/6-8/12	Harmonic motion (Ch 14) Waves (Ch 15-16)	2pm-4pm, 8/8 1pm-5pm, 8/9
7	8/13-19	Thermodynamics (I) (Ch 17-20)	2pm-4pm, 8/15 1pm-5pm, 8/16
8	8/20-26	Thermodynamics (II) (Ch 17-20)	2pm-4pm, 8/22 1pm-5pm, 8/23
9	8/27-31	Final Exam	1pm-5pm, 8/29

- 詳細課程內容

Chapter 1-3: Introduction, Kinematics in One, Two, or Three Dimensions

1) Order of Magnitude: Rapid Estimating (section 1-6)

a) Example: the surface area of a basketball

b) Estimate the number of molecules in atmosphere

c) Reading assignment: Example 1.4

d) Dimensions and Dimensional analysis

e) PRS1-2: What are the dimensions of energy?

i) Example: how much time does it take for dropping an apple from height *h*?

ii) GP1-1: speed of deep water wave

iii) GP1-2: Speed of wave ripples (Capillary wave)

iv) Vectors and Scalars: basic vector operations

v) Reading assignment: Examples: 1-8, 1-9, 1-10, 1-11, and 1-12

2) Kinematics

a) Reference Frames, Displacement and average velocity (sec. 2-1, 3-1)

b) Instantaneous velocity (sec. 2-2, 3-1)

c) Acceleration (sec. 2-3, 3-2)

i) Reading assignment: examples: 2.1, 2.2, 2.3, 3.1, and 3.2

d) 1D Motion

i) Knowing $x(t)$ to calculate $v(t)$ and $a(t)$: derivative

(1) Special case: Constant Acceleration and Freely Falling Objects (sec. 2-4, 2-5)

(2) Example 2-5: Police and speeder, **GP2-1**: Mary and Sally (prob.2-47)

(3) Basic Calculus: derivatives (appendix B)

ii) Knowing $a(t)$ to calculate $v(t)$ and $x(t)$: integration

(1) Variable Acceleration; Integral Calculus (Sec. 2-6)

(2) **GP2-2:** integrating a time-varying acceleration (**GP2-3,** GP2-4)

(3) Basic Calculus: integrals (appendix B), techniques of chain rule and change variables

iii) GP2-5: $a(t) = c_0 - c_1 v(t)$

e) 2D motion: Projectile Motion (Section 3-3)

i) DEMO expt.: Stuff animal and projectile motion

ii) **GP 3-4: Ski-jumper**

iii) GP 3-5/6: Throwing a stone down/up a hill

iv) GP 3-7: challenge one

v) **GP 3-3: Throw a grenade** (two objects with relative motion)

f) 2D motion: Motion in a circle (section 3-4, move to ch 5)

g) Relative motion (section 3-5): **GP 3-1 (example 3-16), GP 3-2**

Chapter 4-6: Application to Friction, Circular motion, Drag force, and Gravitation

1) Newton's Laws (section 4-1 ~ 4-5)
2) Interactions and Forces
   a) Gravitational force
   b) Hook's law for elastic restoring force
   c) Tension force
   d) Normal force
   e) Kinetic/static friction
   f) PRS4-2~4-3: mass or weight
3) Solving Problem with Newton's Laws (section 4-6 ~ 4-8)
   a) Free Body Diagrams: example 4-13: Atwood's machine
   b) GP 4-1: pull up by himself through pulleys
   c) GP 4-2: Atwood's machine with accelerating pulley
   d) GP4-2a: double Atwood's machine (problem 4-56)
   e) GP 4-3: another pulley problem (challenge one)
   f) Problem 4-59 in textbook
4) Application of Newton's Laws – involving friction (section 5-1)
   a) GP 5-1 and 5-2: Problem 5-31, GP 5-2 is similar to 5-1
   b) Example 5-7: ramp, pulley and two boxes
   c) GP 5-3: problem 5-32
   d) Reduce friction: video Flea Circus by Prof. Heckler
   e) Problem 5-33: optional
5) Circular motion (section 5-2 ~ 5-4, 6-1~6-4)
   a) Uniform Circular Motion - Kinematics
   b) Uniform Circular Motion – Dynamics
   c) PRS 5-2~ 5-9, GP 5-4: Ex. 5-13 (conical pendulum)
   d) Highway Curves: Banked and Unbanked: Ex 5-14 and 5-15 (GP 5-6)
   e) Nonuniform Circular Motion: PRS 5-10 and 5-11, GP 5-5: Ex. 5-12 (vertical circular motion),
   f) Satellites and Newton's law of universal gravitation: Geosynchronous satellite: example 6-6
6) Mass and weight: what is "weightless" (sec. 6-4)
7) Velocity-dependent force: Drag and terminal velocity
   a) Example 5-17: force proportional to velocity

Chapter 7-8: Work, Energy and Conservation of Energy

1) Work done by a constant force
   a) Work done by the gravity near the earth's surface
   b) Work-energy principle (theorem) (1D case)
   c) Example 7-2: work down on a backpack
2) Work done by a varying force
   a) Example 7-6: force as function of *x*
3) Kinetic Energy and the Work- Energy Principle
   a) GP 7-1: work-energy theorem, block moving toward a spring
   b) GP 7-2: small cube moving toward an incline with friction
   c) Find the potential if we know the force
      i) Gravitational force near the earth's surface
      ii) Spring
      iii) Gravitational force
4) Find the force if we know the potential
      i) Gravitational force (near the earth's surface)
      ii) Spring
      iii) Gravitational force
5) Concept of the conservative force
6) Potential energy related to force:
   a) Gravitational force (near the earth's surface)
   b) Spring
   c) Gravitational force
   d) GP 8-1: find *F* from given *U*
   e) GP 8-2: Example 8-8, two kinds of potential energy
   f) GP 8-3: a swinging pendulum (similar to example 8-9)
7) Energy conservation with dissipative force
   a) GP 8-4/8-5: work-energy theorem
8) Escape velocity, Power, and Energy diagram
   a) Example 8-13: Escaping from the earth/moon

Chapter 9: Linear momentum

1) Momentum and Its Relation to Force
2) Conservation of Linear Momentum
3) Collision and Impulse*
   a) Example 9-6: impulse
   b) Elastic collision: tennis ball and basketball: DEMO and PRS9-1, PRS9-2
   c) PRS9-3, PRS9-4: bowling ball and ping-pong ball
4) 1D and 2D collision (reading assignment)
   a) Elastic and inelastic collision, completely inelastic collision
   b) Example 9-11: Ballistic pendulum
5) Center of Mass
   a) Example 9-15: three particles in 2D
   b) Example 9-16: CM of a thin rod
   c) GP 9-1: CM of L-shape flat object (example 9-17)
   d) GP 9-2/ GP9-3: CM of a disk with a hole and solid sphere with a spherical hole
6) Motion of system of particles
   a) Center mass frame and lab frame: completely inelastic collision
   b) GP 9-4: exploding projectile
7) Recitation
   a) GP 9-5: collision of two blocks with a spring
   b) GP 9-6: CM of a traffic cone and half sphere.
   c) GP 9-7: CM of a triangular shape of cheese.
8) Rocket problem

Chapter 10-11:
Rotational Motion; Angular Momentum; General Rotation

1 Rotation: angle, angular velocity and angular acceleration (sec. 10-1 ~ 10-3)
   a) Angular displacement, angular velocity, and angular acceleration
   b) Ex.: 10-1 (concept of radians), 10-2 (concept of linear velocity and angular velocity),
   c) Ex.: 10-3: angular and linear of velocity and acceleration
   d) Ex.: 10-4 (hard drive)
   e) Ex.: 10-5 (time dependent of angular velocity/acceleration)

2 Kinetic energy of rotation (Sec. 10-8) and Moment of inertia (Sec. 10-5, 10-7)
   a) Same masses but different geometries (sphere, cylindrical, hollow, … etc.) have different moment of inertia (PRS 10-3 and 10-4)
   b) DEMO: Ex. 10-17, which one (sphere, hollow, cylindrical …etc) is the fastest?
   c) Same structure (e.g., disc), different rotating axis (PRS 10-5)
   d) How to calculate the "Moment of inertia": Ex 10-12: moment of inertia of cylinder of solid or hollow + disk and rod, together with Lab 6 calculating the moments of inertia of these three ones
   e) Parallel axis theorem (Ex 10-13): explain the result in PRS 10-5 again
   f) Perpendicular axis theorem (Ex: 2D examples, PRS 10-6)
   g) GP 10-1: moment of inertia, I_x, I_y, and I_z of a rectangular paper
   h) Quiz: calculate the moment of inertia of a "T" rod.
   i) GP 10-2: disc cut out a small disc
   j) Examples: ($KE = KE_{linear} + KE_{rotational}$)
      i) Ex.: 10-14,: flywheel
      ii) Ex.: 10-15: rotating rod

3 Angular momentum (Sec. 11-1, 11-3)
   a) Magnitude, direction, dependence of the reference point: GP 10-3 ~10-7 and PRS10-8~10-11
   b) Orbital angular momentum: projectile and circular motion
   c) Spin angular momentum
   d) Conservation of angular momentum: PRS 10-12 (figure skater)
   e) Ex.: 11-4, 11-5 (DEMO)
   f) Example 11-2

4 Torque (Sec. 10-4, 10-5, 10-6, 11-2 and 11-3)
   a) Ex. 10-7: torque on a compound wheel
   b) Ex. 10-9: a heavy pulley, Ex. 10-10: pulley and bucket
   c) Ex. 10-11: rotating rod
   d) GP 10-8: Atwood's machine, (Ex. 11-8)
   e) Ex. 10-19: yo-yo problem
   f) GP 10-9: problem 10-98

5. Rotational kinetic energy (again), Work and power in rotational motion:
   a) GP 10-10 (w/ PRS 10-14)
   b) GP 10-11: rolling down an incline (with PRS 10-15), static friction
   c) GP 10-9: (problem 10-98)

6 Rolling problem (Sec. 10-9, 10-10,11-)
   a) Pure roll: rolling without slipping
   b) Rotational + translational motion
   c) Ex.: 10-16, 10-17 (DEMO), 10-18: rolling down an incline
   d) Slipping: friction in a rolling problem: ex. 10-20
   e) Problems of Rolling of Bicycle and bowling ball (using (i) force and (ii) angular momentum)
   f) Why does a rolling sphere slow down?

7 Angular momentum and torque of a system of particles (Sec. 11-4, 11-5, 11-6)
   a) Orbital and spin angular momentum (again)
   b) Conservation of angular momentum
   c) Angular momentum and torque of a rigid body
   d) Ex. 11-8: Atwood's machine (again, solving with angular momentum)
   e) Ex. 11-11: Kepler's 2nd law

8 Angular momentum conservation: Rotational collision
   a) Ex. 11-12: Bullet strikes cylinder edge
   b) GP 11-2 (problem 11-51)
   c) Problem 11-52: cue ball in a billiard table
   d) Static friction in a rolling problem: Lab XX, constant F on a yo-yo sitting on a table, Problem 10-96 (stick on a billiard ball), sweat spot on a bat (prob. 11-82)
   e) Other examples: Problem 11-48, 11-49, 11-50

9 The spinning top and Gyroscope (Sec. 11-7)

10 The Coriolis effect (Sec. 11-8, 11-9, optional)

Chapter 12: Static Equilibrium and Elasticity (optional for 3 units)

1) The condition of Equilibrium
   a) Example: Ladder problem
2) Stability and Balance
3) Elastic properties of Solids
   a) Stress, Strain, and Elastic Modulus
4) Fracture
5) Bulk Modulus

Chapter 13: Fluids (optional for 3 units)

6) Pressure in Fluids
7) Pascal's principle
8) Archimede's Principle
9) Fluid in Motion
10) Bernoulli's equation

Chapter 15-16:Waves and Sound (optional for 3 units)

1) Types of Waves: Transverse and Longitudinal
2) Energy Transported by Waves
3) The Wave Equation
4) The Principle of Superposition
5) Reflection and Transmission
6) Interference
7) Standing Waves; Resonance
8) Characteristics of Sound
9) Mathematical Representation of Longitudinal Waves
10) Intensity of Sound: Decibels
11) Sources of Sound: Vibrating Strings and Air Columns
12) Interference of Sound Waves; Beats

Chapter 14: Oscillations

1 Simple harmonic oscillation (SHM) (sec. 14-1 ~ 14-3)

a) Spring and SHM (AF 1510, AF 0816)
b) Reading assignment: Ex. 14-1, 14-2, 14-4, 14-6 ,
c) GP14-1 (Ex 14-5): Spring calculation
d) Phase of the motion of a SHM (PRS 14-2, 14-3)
e) Energy in SHM, Ex 14-7
f) Simple Pendulum: equation of motion (AF 1511)
g) PRS 14-7~14-9

2 The physical pendulum and the torsion pendulum (Sec. 14-6)

a) Physical pendulum: derive the equation of motion of a physical pendulum using torque
b) Torsion pendulum

3 Damped Harmonic Motion (Sec. 14-7)

a) Damping term, underdamped, critical damped, and overdamped
b) Example 14-11 (optional)

4 Forced Oscillations; Resonance (Sec. 14-8)

a) Force oscillation: nature frequency, resonance/resonance frequency.

Chapter 17-20: Thermodynamics:

- **Ch 17: Temperature, Thermal Expansion, and the Ideal Gas Law**
  1) Temperature – the 0th law of thermodynamics
  2) Thermal equilibrium
  3) Temperature Scale
  4) Thermal expansion
  5) Ideal gas
  6) The state function for ideal gas
  7) Thermal expansion
  8) Heat Transfer: Conduction, Convection, and Radiation
- **Ch 18: Kinetic Theory of Gase**
  1) Boltzmann constant
  2) Kinetic-Molecular model of an ideal gas: microscopic model for ideal gas
  3) Kinetic energy of a molecular gas and its relation to pressure/temperature
  4) Average velocity and the distribution of molecular speed
  5) Phase diagram
     a) Vapor pressure and humidity
     b) Partial pressure and relative humidity
     c) Boil point
     d) Dew point
  6) Van der Waals gas
- **Ch 19-20: Heat and the First Law of Thermodynamics and Second Law of Thermodynamics**
  1) Temperature
  2) Heat and Internal Energy
  3) Processes and State variables
     a) Work and Heat
     b) Pressure, Temperature, Volume
  4) The First Law of Thermodynamics
  5) The Equipartition of Energy
  6) Example: Work in p-V plane
  7) Specific heat and Latent Heat
  8) Thermal equilibrium and the zeroth law of thermodynamics
  9) Processes vs state variables
  10) Internal energy
  11) The first law of thermodynamics
  12) Thermodynamic processes (find the **changes** of work, heat, internal energy in each process from point A (V_A, T_A, P_A) to Point B (V_B, T_B, P_B)
      a) Isobaric

b) Isochoric/isovolumetric
c) Isothermal
d) Adiabatic

13) What is the thermodynamic cycle?
14) Heat engines
15) The efficiency in a thermodynamic cycle
16) The second law of TD: Kelvin Plank vs Clausius
17) "The Reversibility" of a thermodynamic process.
18) Refrigerator and coefficient of performance (COP)
19) The "Irreversible process" in thermodynamic?
20) Example: the "free expansion" and the changes of thermodynamic variables in free expansion (temperature, volume, pressure etc…).
21) Carnot's engine
22) The changes of the thermodynamic variables in each process in a Carnot's cycle working in two different temperatures.
23) The efficiency in a Carnot's cycle?
24) "The third law of TD and the thermodynamic temperature.
25) Entropy
    a) Introduction and definition
    b) Evaluate the entropy change in (i) Isothermal process (ii) Isobaric process (iii) Isovolumetric process (iv) adiabatic process
26) Statistical interpretation
    a) Order to Disorder
    b) Entropy