TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

MECHANICS AND HEAT

by

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PREFACE

In the course of Mechanics and Heat, students study the various topics about the basic concepts of physics in the field of Mechanics and Heat. The topics are measurements and calculations, mechanical state of systems and the effects of the force, gravitational interaction of two bodies, fluids, periodic motions and mechanical waves, thermodinamic state of gas, and various thermodinamic relationship. The teacher centered learning is used to taught in the classroom. In this learning method, the students listen to lecture's explanations of basic concepts and some examples. Students practice the mastery of the material by doing a structured task of homework.

Moreover, the students centered learnings are applied by interactive lectures, questioned learning, computer assisted learning, and project based learning. The question-based learning and project-based learning methods implemented in the group to give students the opportunity to practice soft skills such as cooperative and communication skills. While computer assisted learning method supported by SCELE (Student Centered E-Learning) UI facility, students can develop using information technology and computer.

This Teaching Instructional Design is prepared for teaching and learning guide at the Department of Physics, FMIPA University of Indonesia. Thus, the learning process by students can be directed and ultimately the learning objectives can be achieved

Depok, 26 November 2017

Efta Yudiarsah, Ph.D.

I. General Information

1.	Name of Program / Study Level	:	Physics / Undergraduate
2.	Course Name	:	Mechanics and Heat
3.	Course Code	:	SCFI601114
4.	Semester	:	1
5.	Credit	:	4 credits
6.	Teaching Method(s)	:	Lecturing, Question based learning, Computer assisted learning dan project based learning
7.	Prerequisite course(s)	:	-
8.	Requisite for course(s)	:	Wave and Vibration, Optics, Basic of Physics Laboratory 1, and Basic of Physics Laboratory 2
9.	Integration Between Other Courses	:	Basic of Physics Laboratory 1, and Basic of Physics Laboratory 2
10.	Lecturer	:	Efta Yudiarsah, Ph.D.
11.	Course Description	:	The Mechanics and Heat course consists of two major topics, mechanics and heat. Active learning methods are applied ie interactive lectures, questioned learning, computer assisted learning, and project based learning. Students have the opportunity to understand the basic concepts, analytic skills and numeracy skills. Students also practice to explain and analyze the natural phenomena and technology both qualitatively and quantitatively that exist in the environment by using basic physics concepts and apply it to everyday life.

II. Course Learning Outcome (CLO) and Sub-CLOs

A. CLO

Students are able to apply the principles and concepts of mechanics and heat for fomulating solutions of problems (**ELOs 1,2,5,6, and 7).**

B. Sub-CLOs

1. To determine significant numbers and units of measurement and the calculations (C3).
2. To find the solution of the problem of object motion in the straight path (C3).
3. To calculate the problem solving motion of an object in the fiels (2D) and space (3D) (C3).
4. To analyze forces that work on objects and their effects on the mechanical states (C4).
5. To find the problem solving of mechanical state of objects under different types of forces (C3).
6. To determine the relationship of mechanical energy and force of objects (C3).
7. To find the solution of conservative and non consevative forces (C4).
8. To calculate the problem solving of momentum changes of one or several objects by internal and external forces (C3).
9. To calculate the rotational motion of objects (C3).
10. To calculate under the influence of force (C3).
11. To demonstrate the system in equilibrium (C3).
12. To demonstrate Newton's law of gravity on particle sytem and celestial bodies (C3).
13. To find the solution problems of static and dynamic fluids (C3).
14. To calculate the change of object dimension due to the temperature changes (C3).
15. To determine the state of gas by speed, kinetic, energy, pressure, temperature, volume and number of molecules (C3).
16. To formulate the heat problem solving involves the mechanical work, energy flow and system energy changes (C4).
17. To determine the eficiency of heat engines and the change of entropy of a system due to a process (C3).

III. Teaching Plan

Week	Sub-CLO	Study Materials	Teaching Method	Time Required	Learning Experiences (*O-E-F)	Sub-CLO Weight on Course (%)	Sub-CLO Achievement Indicator	References
1	1	Unit, Scale and Vector	Lecturing	200 minutes	20% O, 60% L, 20% U	6	Explain the concept and calculation of Physics and law nature, magnitude and units, unit conversion and consistency, estimation and order of magnitude, vectors, vector sum and vector multiplication	Unit 1 and Unit 3
2	2	Motion along the straight lines	Lecturing	200 minutes	20% O, 60% L, 20% U	8	Explain the concept and calculation of moving, time and average speed, instantaneous velocity, average and instantaneous acceleration, motion with constant acceleration, and free falling objects	Unit 2
3	3	Motion in 2 or 3 dimensions	Lecturing	200 minutes	20% O, 60% L, 20% U	6	Explain the concept of vector of position and speed, acceleration vector, ball move, circular circular motion, relative speed	Unit 4
4	4	Force, Newton's Law	Lecturing	200 minutes	20% O, 60% L, 20% U	6	Explain the concept of force, Newton's Law 1, Newton's Law II,	Unit 5

							Newton’s Law III, mass and weight, free item diagrams	
5	5	Newton's Law Application	Lecturing	200 minutes	20% O, 60% L, 20% U	8	Explain the concept of the use of Newton's Law 1: particles in equilibrium, usage of Newton's Law 2: particle dynamics, friction style, and circular motion dynamics	Unit 6
6	6	Work, and Kinetic Energy	Lecturing	200 minutes	20% O, 60% L, 20% U	6	Explain the concept of work, kinetic energy and working-energy, work and energy Theorem	Unit 7
7	7	Potential energy and conservation of energy	Lecturing	200 minutes	20% O, 60% L, 20% U	6	Explain the concept of potential gravity energy, elastic potential energy, conservative and non-conservative force, force and potential energy and energy diagrams	Unit 8
8	8	Momentum, impuls and collision	Lecturing	200 minutes	20% O, 60% L, 20% U		Use momentum and impulse, momentum and collision moments, elastic and inelastic collisions, mass center, mass moving system changed	Unit 9
9	**Mid Term Exam**							
10	10	Rotation of the rigid body	Lecturing	200 minutes	20% O, 60% L, 20% U	8	Explain torka, torka and	Unit 10

							acceleration of strong angle, work and motion style rotation, angular momentum, angle momentum angle, gyroscope and precision	and Unit 11
11	11	Dynamics of rotational motion	Lecturing	200 minutes	20% O, 60% L, 20% U	8	Explain condition of balance, gravity Center, settlement of equilibrium balance, voltage, strain, elasticity modulus, elasticity and plasticity	Unit 12
12	12	Gravity	Lecturing	200 minutes	20% O, 60% L, 20% U	8	Explain Newton's gravity Law, weight, Kepler's Law and planet motion, gravity potenisial energy, satellite motion, and black holes	Unit 13
13	13	Fluid mechanics	Lecturing	200 minutes	20% O, 60% L, 20% U	8	Describe the concept of Physics at; density, fluid pressure, Bernouli equation, viscosity and turbulence	Unit 14
14	14	Temperatures	Lecturing	200 minutes	20% O, 60% L, 20% U	8	Describes the concept of an ideal gas molecular model, ideal gas molar type heat, ideal gas adiabatic process, energy ecipartition, Botzman distribution law, and average velocity and molecular distribution	Chapter 18 (sub chapters 1-6) and Chapter 19 (sub chapters 1-3), Chapter 19 (sub chapters 4-11)

15	15-17	Gas Kinetic Theory; Heat and Law of Thermodynamics 1	Lecturing	200 minutes	20% O, 60% L, 20% U	8	Explaining the concept of heat and energy in caloric type and calorimetry, latent heat, work and heat in the process of thermodynamics, Law I thermodynamics, application of Law I thermodynamics, and energy transfer mechanism, explaining the concept of the calor engine and the law of thermodynamics, pumps of heat and radiation , reversible and irreversible processes, carnot machines, gasoline and diesel engines, entropy and entropy change in irreversible processes as well as entropy in microscopic scale	Chapter 18 (Chapters 7-12) and Chapter 20
16	**Final Exam**							

*) O : Orientation
E : Exercise
F : Feedback

References:

1. Halliday, Resnick, dan Walker, *Principles of Physics 9th Edition*, Wiley, 2011.
2. Serway Jewett,*Physics for Scientists and Engineers 7th Edition*, Thomson Brooks/Cole, 2010.
3. Giancoli, *Physics for Scientists and Engineers 4th Edition*, Pearson, 2008

IV. Assignment Design

Week	Assignment Name	Sub-CLOs	Assignment	Scope	Working Procedure	Deadline	Outcome
1	Individual assignment 1	1	Problem set	Units, scales and vectors	Homework	1 week	Homework answer sheet
2	Group assignment 1	2,3	Problem set	Motion along straight lines and Motion in two and / or three dimensions	Group discussion	1 week	Presentation file in *power point* format
3	Individual assignment 2	4,5	Problem set	Newton Law and the its application	Homework	1 week	Homework answer sheet
4	Group assignment 2	6,7	Problem set	Work on kinetic energy and potential energy and conservation of energy	Group discussion	1 week	Presentation file in *power point* format
5	Individual assignment 3	8,9	Problem set	The momentum of impulses and collisions and the rotation of strong bodies	Homework	1 week	Homework answer sheet
6	Group discussion 3	10	Problem set	Dynamics of rotational motion	Group discussion	1 week	Presentation file in *power point* format
7	Individual assignment 4	11	Problem set	The Equilibration and Elasticity	Homework	1 week	Homework answer sheet
8	Group discussion 4	12	Problem set	Gravity	Group discussion	1 week	Presentation file in *power point* format
9	**Mid Term Exam**						
10	Individual assignment 5	13	Problem set	Fluid Mechanics	Homework	1 week	Homework answer sheet
11	Individual assignmnet 6	14,15	Problem set	Temperature and gas kinetic theory	Homework	1 week	Homework answer sheet
12	Individual assignment 7	15,16	Problem set	Heat and law of thermodynamics I	Homework	1 week	Homework answer sheet

13	Individual assignment 8	16,17	Problem set	Heating machine and law of thermodynamics II	Homework	1 week	Homework answer sheet
14-15	Group assignment	Several sub-topics 1- 15	Project Task	Several sub-topics 1- 15	Group assignment	6 week	Poster and paper
16	**Final Exam**						

V. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLOs	Assessment Type	Frequency	Evaluation Weight (%)
Post- and Pre-test	1-17	Quiz in SCELE	26	7
Quiz	1-17	Answer sheet	4	15
Individual assignment	1,4,5,8,9,11,13,14,15,16,17	Answer sheet	17	7
Group assignment	2,3,6,7,10,12	Assesmentsheet	1	4
Active	1-17	Assesment sheet	1	4
Mid Term Exam	1-8	Answer sheet	1	30
Final Exam	10-15	Answer sheet	1	30
Total				**100**

VI. Rubric(s)

A. Criteria of Self-Assignment

Score	Answer Quality
>90	If the student can complete more than 90% problem correctly
70-89	If the student can complete more than 70% - 89% problem correctly
60-69	If the student can complete more than 60% - 69% problem correctly
55-59	If the student can complete more than 55% - 59% problem correctly
50-54	If the student can complete more than 50% - 54%problem correctly

B. Criteria of Group Papers

Score	Answer Quality
90-100	If students can apply basic concepts in explaining on natural phenomena and technology with 80-90% accuracy, coherence and correct language
70-89	If students can apply basic concepts in explaining on natural phenomena and technology with 70-89% accuracy, coherence and correct language
60-69	If students can apply basic concepts in explaining on natural phenomena and technology with 60-69% accuracy, coherence and correct language

C. Quiz, Mid Term Exam and Final Exam

[1] Able to determine the basic concepts that are appropriate in the solution of the problem (35%)

[2] Able to formulate a final solution to fix languages errors (30%)

[3] Able to use the appropiate units and important numbers 10%

VII. Appendix: Example of Exam Problems

EXAMPLE OF ASSIGNMENTS AND EXAM (MID TERM, FINAL EXAM, ETC)

Appendix 1. Example of Assignments

1. Example of group assignment:

Group assignment. Discuss, how do the airplanes can fly. Analyze the phenomenon based on basic physical principles 1. Write a report in the form of papers and posters. Posters will be presented in the twelfth week.

2. Example of individual assignment:

Individual assignment 1; Unit, Scale, and Vector. Work on the major textbooks (Halliday) Chapter 1 on numbers: 1, 16, 26, 36, and 46, and Chapter 3 on numbers: 2, 13, 24, 36, 50, and 60.

Appendix 2. Example of Evaluation Test

1. Multiple Choice

1. When the brake pedal on the car is stepped on, the road provides the greetest drag style:
   A. when the wheel rolls
   B. just before the wheels slide
   C. when the car is moving fastest
   D. when the smallest accelaration
   E. when the speed starts to change

2. 12 N horizontal force is used to draw 240 N logs at a constant velocity over a horizontal floor. The coefficient of friction of the floor surface is equal to:
   A. 0,5
   B. 0,05
   C. 2
   D. 0,2
   E. 20

3. The 4 N of hockey speed, which slips across the ice surface, decreases at a rate of 0.61 m/s^2. The kinetic friction coefficient between the ball and the ice is equal to:
   A. 0,062
   B. 0,41
   C. 0,62
   D. 1,2
   E. 9,8

2. Essay

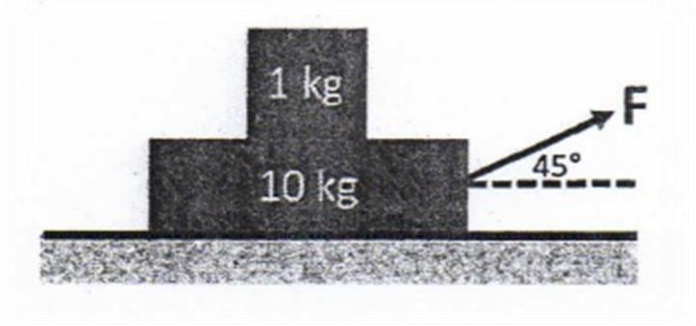
A spacecraft unleashed a communications satellite with a mass of 475 kg while orbiting the earth at an altitude of 281 km. Satellite rockets put satellites into geosynchronous orbit, where satellites orbit the Earth in the same period as the Earth's rotation period so that satellites are always above a point on the earth's surface. (30 points)

a. Sketch the case !
b. Find the position ($\vec{r}$) of geosynchronous orbit from the center of the earth and the earth's gravitational field in this orbit ($\vec{g}_{bumi}$) !
c. Find the energy that the rocket should provide when putting a satellite in orbit !

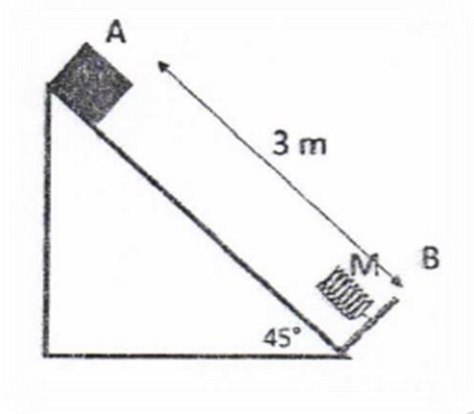
Appendix 3. Example of Mid Term Exam.

1. A horizontal fighter plane is moving horizontally at a rate of 900 km/h at an 2 km hight from the earth's surface, releasing a massive 500 kg bomb. Right above the aircrushing aircarft cannon pierced by a cannon gun with a speed of 0,05 from the initial cannon ball speed. Calculate:
   a. The initial velocity of the cannon,
   b. The angle of the cannon when fired to allow the bomb dropped by the aircraft to be shot and destroyed by a gun cannon prior to the air defect.

2. A mass of 1 kg is above a 10 kg object as in the picture. Both are equally motionless. The force F that attracts objects in the direction of 450 varies with time, F = 0.2t Newton. If the static friction coefficient is 0.2 and the kinetic frictional coefficient is 1.5 between all surfaces. Find the equations of motion of each body as a function of time.



3. An A object in the picture below has a mass of 0.5 kg. First, it was in silence then slide as far as 3 m above a smooth field that forms an angle of 450 with horizintal to strike the spring M. One of the spring ends of B is related at the end of the plane. The spring constant k = 400 N / m. Calculate the maximum deviation of the spring and the oscillation frequency of the object after mashing a sticky object with a spring.



4. Two objects are connected with a piece of string as like the picture (m_1= 6 kg). If one of the two objects are stationary, the coefficient of friction of the object with a 0,2 incline and a slope of the plane is 300. Calculate:

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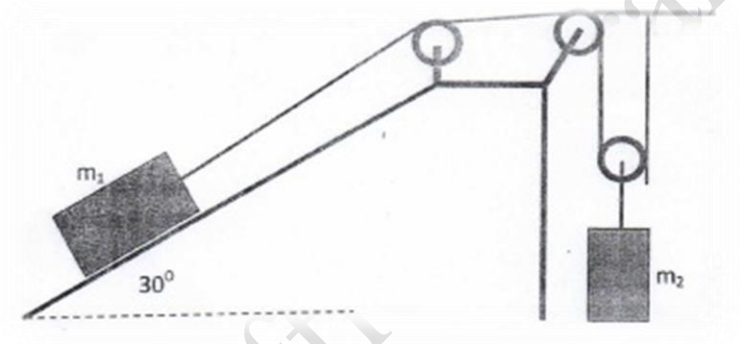

(a). The force strap that connect of two objects;
(b). The acceleration of the second object (m_2);
(c). The line of the first object (m_1) after 5 second

5. 6,5 x 10^6 kg of water is estimated to fall from niagara waterfall (which is 50 cm of high) every second. Calculate:
   a. the reduction of the gravitational potential energy of the earth-water system every second?,
   b. if all energy can be converted to electrical energy, what rate is the electric energy being monitored? (mass of 1 m3 of water is 1000 kg),
   c. if electric energy is sold at 1 cent / kW.hour, How is the income per year?