MATHEMATICAL MODELLING

COURSE CODE: PAM 303

4 SCU

SEMESTER V

BY:

MATHEMATICS STUDY PROGRAM
MATHEMATICS AND NATURAL SCIENCES FACULTY
DIPONEGORO UNIVERSITY
SEMARANG

LEARNING PROGRAM OUTLINE

Course Name : Mathematics Modelling
Code/Credit : MAT 324 / 4
Short Discription : This course containes using of Mathematics and Process of Mathematics Modelling in the science and engineering.
General Instructional Aim : After studying this course, student of Mathematics expected can understand modelling process and differentiating equation of mathematics model in phisycs ang biology.

No	Specific Instructional Aim	Subject	Sub Subject	Time Estimation	References
1	After studying the lecture this (by the end of meeting to 1), student can understand process and usage modelling of mathematics to finish the problem of reality	Mathematical Modelling Process	Introduction, approach, and modeling process of mathematics	100 mnt	4
2	After studying the lecture this (by the end of meeting to 3), student can	Population model	1. Dicrete model of one species 2.Continu model (Exponential) 3. Application to real probem	2x100 mnt	2, 4
3	After studying the lecture this (by the end of meeting to 5), student can	Discrete model with age distribution	1.Congeniality of model growth of population with age distribution 2.Equation of matrix model growth of population with age distribution	2x100 mnt	2
4	After studying the lecture this (by the end of meeting to 7, student can	Probabylistic Model	1.Arranging equation system (mathematics model) of probability model 2.Solution from equation system for the model of probability	2x100 mnt	2, 4
5	After studying the lecture this (by the end of meeting to 9), student can	Growth model depends with density	1.Form of logistic equation 2.Solution of phase area of equation of logistics 3.Explicit solution of equation of	2x100 mnt	3, 4

			logistics		
6	After studying the lecture this (by the end of meeting to 1), student can	PopulEquipmention model of 2 specieses	1.Balancing and linearitation of populayion model 2 specieses 2. Balancing of population model 2 specieses 3. Application to real	3x100 mnt	3, 4
7	After attend the lecture this (by the end of meeting to 13), student expected can explain and degrade equation of mathematics model about movement in direction of horizontal from a[n mass bound by spiral spring.	Spring-Mass movement without friction	Equation of mass movement model Model Equation of balance position Sotion of equaton	100 mnt	2, 4
8	After attend the lecture this (by the end of meeting to 14), student expected can explain and degrade equation of mathematics model about mass motion of vertical influenced by gravitation style.	Vertical spring mass movement	Equation of mass movement model Model Equation of balance position Sotion of equaton	100 mnt	2, 4
9	After attend the lecture this (by the end of meeting to 15), student expected can explain and degrade equation of mathematics model about oscillator mass motion.	Two mass movement	Model equation of center mass movement Problem of boundary condition Analysis of system behavior	100 mnt	2, 4
10	After attend the lecture this (by the end of meeting to 16), student expected can: explain and degrade equation of mathematics model about mass motion bound by two spiral spring by horizontal.	One mass movement	Equation of model balance position justifikasi if spiral spring length and konstanta vary. Equation of model to balance position. solving of equation of model behavioral analysis [of] system	100mnt	2, 4
11	After attend the lecture this (by the end of meeting to 17), student expected can: explain and degrade equation of mathematics model of system mass spiral spring of spiral	Movement f spring mass system	1.Model equation 2.Balance position 3.Model Equation of balance	100mnt	2, 4

	spring formation compiled by parallel and series.		position 4. Solution of model equation 5. Analysis of behavior system		
12	After attend the lecture this (by the end of meeting to 18), student expected can: explain and degrade equation of mathematics model of system spiral spring mass by paying attention style of friksi.	Movement of spring mass system with friction force.	Model equation Friction Force Oscilation of damped system Oscilation of underdamped system Osilasi of Overdamped and critically damped system	100 mnt	2, 4
13	After attend the lecture this (by the end of meeting to 19), student expected can: explain and degrade equation of mathematics model about movement of pendulum	Movement of pendulum	1. Equation of model in polar coordinate 2. Balance Position 3. Linearization of equation 4. Analysis of behavior movement of pendulum	100 mnt	1, 4
14	After attend the lecture this (by the end of meeting to 20), student expected can: explain linear system	Linarization of system	Taylor method System without non linear friction	100 mnt	2, 4
15	After attend the lecture this (by the end of meeting to 21), student student will be able to expected can: analyse balance solution stability	Analysis of stability	Taylor approach Perturbation method Analysis of stability and unstability of non linear system.	100 mnt	2, 4
16	After attend the lecture this (by the end of meeting to 22), student	Energy Conservation	Kinetic Energy	100 mnt	2, 4

	expected to explain energy conservation.		Potential Energy Analysis of stability using approach energy concept.		
17	After attend the lecture this (by the end of meeting to 23), student expected can: explain curve of energi from an system.	Energy curve	1. Phase plane 2. Behavior of system usingapproach of phase plane 3. Phase plane of linear oscilation.	100 mnt	2, 4
18	After attend the lecture this (by the end of meeting to 24), student expected can: explain behavior of pendulum system.	Biandg fase pendulum	1. Behavior of qualitative of non linear oscillator linier. 2. Trayektory in phase plane	100 mnt	2, 4

References

1. Fowkes, N.D and Mahony, J.J., *An Introduction to Mathematical Modelling*, John Wiley & Sons, 1994.
2. Haberman, R, *Mathematical Models in Mechanical Vibrations, Population Dynamic, and Traffic Flow*, Prentice Hall Inc, Englewood Cliffs, New Jersey 07632, 1971.
3. Murray, J.D, *Mathematical Biology*. Heidelberg Berlin : Springer Verlag, 1993.
4. Widowati and Sutimin, *Buku Ajar Mathematics Modelling*, Jurusan matematika FMIPA UNDIP Semarang, 2007

UNIT PROGRAM OF LECTURING

Course : Mathematics Modelling
Code of course : MAT 324
Credit : 4
Time Lecturing : 1 x 100 minutes
Week : 1

A. Instructional Aim

1. General.

   After studying this course, student can understand of general description of Mathematics modeling in its relation with other science area and and also its application in problem of reality, unit program of lecturing and of Learning program outline and also course contract.

2. Specify.

   After studying this course, student can:

   a. Explain general description of this course
   b. Explaining bearing of Mathematics Modellingwith other area and its application in problem of reality.
   c. Determining strategy learn.

B. Subject: Introduction

C. Sub Subject:

General discripton of mathematics modelling
Relation of mathematics modeling with physic, mechanic, and biology in real problem
Explaining unit program of lecturing, learning program outline and also course contract.

D. Lecturing Activity:

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Explaining lecturing system of Mathematics modelling, in unit program of lecturing, learning program outline and lecturing contract.	Hearing and writing	Blackboard
Presentation	Menjelaskan pengertian, pendekatan, and proses Mathematics Modelling and kaitannya dengan ilmu Fisika and Biologi. Menjelaskan aplikasi Mathematics Modelling dalam real problems solving.	Writing and Doing assignment.	OHP and Blackboard.
Closing	1. Pembagian kelompok asal 2. Memberikan pengantar ke materi berikutnya.	Writing anggota kelompoknya	Writing book and blackboard.

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
Credit : 4
Time of Lecturing : 2 x 100 minutes
Week : 2 and 3

A. Instructional Aim

1. General.

   After studying this subject, student can be expected explaining population model.

2. Specify.
   After studying this subject, student can:
   Explaining discrete model one species and continu model (Exponential)

B. Subject: Population model.
C. Sub Subject:

Discrete Model one species
Continu Model (Exponential)

D. Lecturing Activity :

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	1. Explaining material will be discuss in Week 5 and 6 2. Giving explanation about using this subject to studying next subject.	Hearing and writing Paying attention	Blackboard
Presentation	1. Re-remember first orde linear differential equation 2. Explaining congeniality of rate of change of population. 3. Explaining of rate of change concept per unit time. 4. Explaining congeniality of rate of birth and rate of death 5. a. Explaining of constant rate of growth b. Giving examples c. Giving exercises abaout population model. 6. Explaining growthing model of exponentiall a. Explaining definition of growthing model b. Explaining difference beetwen exponential model and growthing ate positive ang negative. c. Giving exercises and examples about population model.	Paying attention Paying attention Paying attention Paying attention Paying attention Doing Paying attention Paying attention Paying attention Doing *brainstorming*	OHP, Tranaparant, Blackboard chalk, chalk, whiteboard and spidol
Closing	1. Giving chance for student to asking. 2. Giving General discription to next lecturing and give topic modul to discuss.	Asking Paying attention	OHP, Tranaparant, Blackboard

			chalk, chalk, whiteboard and spidol

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 2 x 100 minutes
Week : 4 and 5

A. Instructional Aim

1. General.

After studying this subject, student can be explained dscrete model with age distribution.

2. Specify.

After studying this subject, student can:
Explaining big congeniality [of] presented population with age distribution and form its equation.

B. Subject: discrete model with age distribution

C. Sub Subject:
Congeniality growthing population mode with age distribution
Matrix equation of growthing model with age distribution.

D.Lecturing Activity :

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1.Explaining congeniality of population with presented with age distribution. 2. Explaining how to arrange system equation of population model with age clasification. 3.Giving problem as 4.Giving exercises 5.Quis	Paying attention Paying attention Paying attention and *brainstorming* Doing Doing	OHP, Tranaparant, Blackboard chalk, chalk, whiteboard and spidol
Closing	3. Giving chance for student to asking. 4. Giving General discription to next lecturing and give topic modul to discuss.	Asking Paying attention	OHP,tranaparant, Blackboard chalk,whiteboard and spidol

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT
CREDIT : 4
Time of Lecturing : 2 x 100 minutes
Week : 6 and 7

A. Instructional Aim

1. General.

   After studying this subject, student can be expected probabilistic model.

2. Specify.

   After studying this subject, student can:
   Arrange system of equation (mathematics model) from probabilistic model and finding solution from equation systemto probabilistic model.

B. Subject: Probabilistic Model
C. Sub Subject:

Arranging system of equation (mathematics model) from probabilistic model
Solution from equation systemto probabilistic model.

D.Lecturing Activity :

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1. Review abaou probability 2. Explaining congeniality of probability model. 3. Giving assumptions that needed to arrange mathematics model from probability model. 4. Explaining the way of forming of mathematics model (in the form of equation of diferensial (PD)) which [is] probability reprecentation of[is level of population. 5. Finding solution differential equation from probability model and ilustration in 6. Studying items in module of[is this topic of expert.	Paying attention Paying attention Paying attention Paying attention Paying attention Discuss kelompok ahli and presentasi	OHP, Tranaparant, Blackboard chalk, chalk, whiteboard and spidol
Closing	1. Giving chance for student to asking. 2. Giving General discription to next lecturing and give topic modul to discuss.	Asking Paying attention	OHP, Tranaparant, Blackboard chalk, chalk, whiteboard and spidol

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 2 x 100 minutes
Week : 8 and 9

A. Instructional Aim

1. General.

   After studying this subject, student can be expected logistic growthing model.

2. Specify.

   After studying this subject, student can be:
   Expected of concep logistic growthing model, finding solution phase plane, and explicit solution from logistic equation

B. Subject: logistic growthing model
C. Sub Subject:
   - General form of logistic equation
   - Phase plane solution from logistic equation.
   - Explicit solution from logistic equation

D.Lecturing Activity :

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1. Explaining concept of logistic growthing model and presentating general form of logistic equation. 2. Giving illustration logistic rate of change. 3. Explaining congeniality of zero population growth. 4. Finding population phase plane from logistic equation. 5. Explaining state of population balancing. 6. Finding explicit solution from logistic equation. 7. Studying items in module of[is this topic of expert.	Paying attention Paying attention Paying attention Doing and discuss Paying attention Paying attention Presentasi	OHP, Tranaparant, Blackboard chalk, chalk, whiteboard and spidol
Closing	1. Giving chance for student to asking. 2. Giving General discription to next lecturing and give topic modul to discuss.	Asking Paying attention	OHP, Tranaparant, Blackboard chalk, chalk, whiteboard and spidol

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 3 x 100 minutes
Week : 10, 11, and 12

A. Instructional Aim

1. General.

   After studying this subject, student can be expected: explaining population model of 2 specieses.

2. Specify.

   After studying this subject, student can be :
   Explaining balancing and linearization procedure population model of 2 specieses, finishing system of Differential equation representating population model 2 specieses ang obtaine stability of balancing population.

B. Subject: Population model of 2 specieses
C. Sub Subject:
   Balancing and linearization population model of 2 specieses.
   Stability of ppulation model of 2 specieses.

D.Lecturing Activity :

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1. Explaining congeniality population model of 2 specieses. 2. Explaining state of balancing population model of 2 specieses 3. Doing linearization system of differential equation with Taylor series 2 variables. 4. Finding solution system of differential equation a. Elimination method b. Matrix method 5. Investigate stability of population around balancing point. 6. Giving examples system of satbil and unstabil differential equation 7. Giving exercises about population model of 2 specieses. 8. Studying items in module of[is this topic of expert.	Paying attention Paying attention Paying attention Paying attention and Doing Paying attention and Doing Paying attention Paying attention Doing Discussion in groups.	OHP, Tranaparant, Blackboard chalk, chalk, whiteboard and spidol
Closing	1. Giving chance for student to asking. 2. Giving General discription to next lecturing and give topic modul to discuss.	Asking	Blackboard, chalk,whiteboard and spidol

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minutes
Week : 13

A. Instructional Aim

1. General.
   After studying this subject, student can be expected: explaining and differentiate equation of mathematics model about movement in horizontal direction from spring mass.
2. Specify.
   After studying this subject, student can be:
   Differentiate equation of horizontal spring mass.
   Explaine analytic behavior movement of horizontal spring mass.

B. Subject: movement of spring mass without frictio.

C. Sub Subject :
   Model equation of movement of spring mass
   Model equation of balance position
   Solution of equation.

D. Lecturing Activity:

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	Explaining congeniality phisyc phenomenon of movement of horizontal spring mass Explaining Newton and Hooke Laws.. Differentiate model mathematics equation of movement of horizontal spring mass	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Doing and discussing.	Writing book and blackboard.

UNIT PROGRAM OF LEARNING

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minutes
Week : 14

A. Instructional Aim

1. General.

   After studying this subject, student can be expected: explaining and differentiate equation of mathematics model movement vertical mass.

2. Specify.

   After studying this subject, student can be :

   Differentiate equation of movement vertical mass.

   Explaining of analytic behavior movement vertical mass.

B. Subject: movement vertical spring mass

C. Sub Subject:

Equation of model movement vertical mass without friction
Model equation of balance position
Solution of equation.

D. Lecturing Activity:

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	Explaining congeniality phisyc phenomenon of movement of horizontal spring mass Explaining effect of gravitation force. Differentiate equation of movement vertical mass.	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Doing and discussing.	Writing book and blackboard.

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minutes
Week : 15

A. Instructional Aim

1. General.

   After studying this subject, student can be expected: explaining and differentiate equation of mathematics model about movement two mass oscillator

2. Specify.

   After studying this subject, student can be

   Differentiating equation of movement two mass oscillating horizontally.

   Explaining analytic behavior two mass movement.

B. Subject: Gerakan dua massa.

C. Sub Subject:

Equation of model two mass horisontally movement.
Equation of model center mass movement.
Solution equation.

D. Lecturing Activity:

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1. Explaining physic phenomenon movement of two mass horisontally. 2. Explaining sentroid. 3. Differentiate equation of model two mass movement 4. To analysis behavior of sentroid movement.	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Doing and discussing.	Writing book and blackboard.

UNIT PROGRAM OF LEARNING

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minute
Week : 16

A. Instructional Aim

1. General.

   After studying this subject, student can be expected: explaining and differentiate equation model of mathematics model about mass movement two spring.

2. Specify.

   After studying this subject, student can be:
   Differentiate equation model of mathematics model about mass movement two spring..
   Explaining movement horizontal mass.

B. Subject: Movement one mass.

C. Sub Subject:

   Equation of movement model of one mass beetwen two spring.
   Model equation to balance position.
   Solution equation.

D.Lecturing Activity:

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1.Explaininh physic phenomenon movement one mass beetwen two spring horizontally. 2.Diffrentiate equation model of movement mass to wall position. 3.Diffrentiate equation model of movement to balance position	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Doing and discussing.	Writing book and blackboard.

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minutes
Week : 17

A. Instructional Aim

1. General.

   After studying this subject, student can be expected to explaine and to differentiate equation of mathematics model system of spring mass which compile parallel and seri.

2. Specify.

   After studying this subject, student can be:
   Differentiating equation of movement which bound two spring parallel and seri.
   Differentiating equation of movement which bound two spring parallel and seri to balance position.

B. Subject: Movement one mass..

C. Sub Subject:

Equation of movement model one mass spring parallel and seriPersamaan model gerakan satu massa-pegas paralel and seri.
Model Equation to balance position.
Solution equation

D. Lecturing Activity:

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1. Explaining physic phenomenon of movement one mass which bound springg paralellel and seri.. 2. Differentiating equation model of mass movement. 3. Differentiating equation model of mas movement to balance position.	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Doing and discussing.	Writing book and blackboard.

UNIT PROGRAM OF LEARNING

(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minute
Week : 18

A. Instructional Aim

1. General.
   After studying this subject, student can be expected to explaine and to differentiate equation of mathematics model system spring mass with friction force
2. Specify.
   After studying this subject, student can be :
   Explaiing movement of spring mass with fiddlely force effect.
   Differentiating movement of spring mass with damped force.
   Differentiating equation of movement which bound with two spring parallel and seri to balance position.

B. Subject: Movement one mass.

C. Sub Subject:

Persamaan model gerakan sistem massa-pegas dengan gaya gesek..
Solution equation.

D. Lecturing Activity:

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1. Menjelaskan fenomena fisik gerakan sistem massa-pegas yang dipengaruhi oleh gaya gesek. 2. Menurunkan model persamaan gerakan sistem massa-pegas. 3. Menjelaskan perilaku analitik sistem	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Doing and discussing.	Writing book and blackboard.

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minutes
Week : 19

A. Instructional Aim

1. General.

   After studying this subject, student can be expected to explaine and to differentiate equation of mathematics modelabout pendulum movement.

2. Specify.

   After studying this subject, student can be expected:
   Explaining of pendulum movement in polar and cartesius coordinate.
   Differentiating pendulum movement equation.
   Simplicity of non linear pendulum movement equation model..

B. Subject: Gerakan satu massa.

C. Sub Subject:
   Equation of pendulum movement model.
   Linearization of pendulum movement equation model.
   Solution equation.

D. Lecturing Activity :

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1. Menjelaskan fenomena fisik gerakan pendulum. 2. Menurunkan persamaan model gerakan pendulum. 3. Penyederhanaan persamaan model gerakan pendulum 4. Menjelaskan perilaku analitik sistem	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Doing and discussing.	Writing book and blackboard.

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minutes
Week : 20

A. Instructional Aim

1. General.

   After studying this subject, student can be expected linearization of model equation from system pendulum movement model and others non linear equation system.

2. Specify.

   After studying this subject, student can be:
   Explaining simplicity of linearization system with Taylor method and perturbation method
   Differentiating equation of linearization model.

B. Subject: Linearization

C. Sub Subject:
   Taylor Method.
   Perturbation Method

D. Lecturing Activity :

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1. Explaining linearization process. 2. Explaining Taylor method Taylor. 3. Explaining perturbation method.	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Doing and discussing.	Writing book and blackboard.

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minutes
Week : 21

A. Instructional Aim
   1. General.

      After studying this subject student can be analysing analytic behavior and stability balance solution from model equation.

   2. Specify.
      After studying this subject student can be:
      To explaine balance solution.
      To explaine and to analysis stability of balance solution.

B. Subject: Stability.
C. Sub Subject:
   Stability blance solution.
   Stability analysis non linear system.

D. Lecturing Activity

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1 Explaining solution of stability method 2 Explaining of Taylor and Perturbation method.	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Doing and discussing.	Writing book and blackboard.

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minutes
Week : 22

A. Instructional Aim
General.

After studying this subject student can be explaining system energy conservation

2. Specify.
After studying this subject student can be:
Explaining system pendulum energy conservation
Explaining behavior of system based energy conservation.

B. Subject: Konservasi energi.

C. Sub Subject:
Kinetic Energy
Potential Energy
Stability Analysis with eternity energy concept
Non Linear system stability analysis.

D. Lecturing Activity :

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	Explaining Kinetic and Potential energy. Explaining behavior of system movement. Obtaining stability.	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Doing and discussing.	Writing book and blackboard.

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minutes
Week : 23

A. Instructional Aim

1. General.

   After studying this subject student can be explaining curve and energy phase plane kurva and biandg fase energi from system.

2. Specify.

   After studying this subject student can be:
   Explaining total energy curve, kinetic energy and potential energy from system.
   Explaining behavior of sustem based energy phase plane.

B. Subject: Curve of energy.

C. Sub Subject:
   Curve of kinetic energy
   Curve of potential energy.
   Stability analysis with concept of eternity energy.

D. Lecturing Activity :

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	1. Explaining and illustrating curve of kinetic, potential, and total energy. 2. Explaining behavior of system movement. 3. Obtaining stability.	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Doing and discussing.	Writing book and blackboard.

UNIT PROGRAM OF LEARNING
(SAP)

Course : Mathematics Modelling
Code of Course : MAT 324
CREDIT : 4
Time of Lecturing : 1 x 100 minutes
Week : 24

A. Instructional Aim
   1. General.

      After studying this subject student can be explaining behavior of pendulum system.

   2. Specify.
      After studying this subject student can be:
      explaining behavior of pendulum system based energy phase plane.

B. Subject: Phase plane of pendulum system.
C. Sub Subject:
   Qualitative behavior of non linear oscilationPerilaku kualitatif osilator tak linier
   Phase plane trayektory

D. Lecturing Activity :

Step	Lecturer Activity	Student Activity	Media & Equipment
Introduction	Review, explaining, and summarizing previous subject.	Hearing and writing	Blackboard
Presentation	Explaining and illustrating curve on phase plane to pendulum system.. Explaining behavior of system movement.	Writing, discuss, and Doing assignment.	OHP and Blackboard.
Closing	1. Giving individual assignment to finishing solution model equation . 2. Giving introduction to next subject	Paying attention and writing.	Writing book and blackboard.

CONTRACT OF LECTURING.

Course / CREDIT : Mathematics Modelling / 4
Semester : Genap 2007/2008
Day/ Time / Room : Tuesday, Friday / 07.30-09.10; 13.00-14.40/ B103
Lecturer : Dr. Widowati, M.Si & Drs. Sutimin, M.Si

A. Short Discription of Course:

Course Mathematics Modelling represent Course [is] obliged to to Program Study student of S1 Mathematics of biandg Mathematics enthusiasm of Terapan studying the problem of Mechanics of and Biological about movement of massa-pegas, pendulum, population and a[n species.**B. Rencana Kegiatan Perkuliahan and Evaluasi.**

Week	Lecturing Materials	Lecturer
I	- Disription of ths course and its relation with others science. - Explaining unit program learning, learning program outline and contract of lecturing. - Approach and process Mathematics Modelling	Dr. Widowati, M.Si
II-III	- Model of Diskrit population one species - Model Kontinu (Eksponensial) - Fast [of] birth - Fast [of] death - Growth rate - Application to problems of reality	Dr. Widowati, M.Si
IV-V	: - Congeniality of model growth of population with age distribution - Equation of matrix model growth of population with age distribution -Age classification -Quis	Dr. Widowati, M.Si
VI-VII	-Compilation of equation sistem from probability model. -Solution of equation system to probability model. -Analysis of solution.	Dr. Widowati, M.Si
VIII-IX	-Compilation of equation sistem from probability model. -Solution of equation system to probability model. -Analysis of solution.	Dr. Widowati, M.Si
X	-General form logistic equation. -Solution of phase plane of logistic equation. -Explisit solution of logistic equation. -Analysis of solution	Dr. Widowati, M.Si
XI-XII	-Balancing -Linarization of population 2 specieses. -Stability analysis of population model 2 specieses. -Application to real problem.	Dr. Widowati, M.Si

	Mid semester Exam	Dr. Widowati, M.Si and panitia ujian
XIII-XV	- Movement of vertical spring mass - Gravitation force - Movement of 2 spring mass. - Boundary value problem. - Analysis of solution	Drs. Sutimin, M.Si
XVI-XVII	- Movement of two spring mass. - Equation of model. - Analysis of solution. - Movement of system of seri spring mass. - Movement of system of parallel. - Solution of characteristic score problem. - Solution of value boundary problem.	Drs. Sutimin, M.Si
XVIII-XIX	- Movement of system of spring mass with friction force. - Behavior of system with difference friction factor. - Pendulum movement. - Simplyfication of equaton of pendulum movement.	Drs. Sutimin, M.Si
XX-XI	- Linearization of system and stability analysis. - Taylor method - Perturbation method	Drs. Sutimin, M.Si
XXII-XXIII	- Energy conservation - Kinetic Energy - Potential energy - Curve of energy - Phase plane - Analysis of behaviorof system .	Drs. Sutimin, M.Si
XXIV	- Laboratory activity	Drs. Sutimin, M.Si Asisten
XXV	- Laboratory activity	Dr. Widowati, M.si Asisten
XXVI	- Phase plane of pendulum - Analysis of system stability	Drs. Sutimin, M.Si
	Final exam	Drs. Sutimin, M.Si and exam commitee

C. Lecturing Strategy

Lecturing method in the form of discourse, discuss, solving of problems practice [in] class and also usage of computing software [in] Laboratory for analysis.

At the (time) of discuss used [by] model of Jigsaw. This Activity [is] [done/conducted] to assist student [so that/ to be] easier study and comprehend concepts which [is] given in lecturing of Mathematics Modelling [pass/through] study of model of Jigsaw which orienting [at] problem open-ended. Model study of type of Jigsaw represent model study of co-operative, with student learn in small group consisting of 4-6 people. Jigsaw designed to increase feel student responsibility to its own study [of] and also study of friend a group of. Student [do] not only studying given items, but them also have to ready to give and teach the the items [at] its other group member.

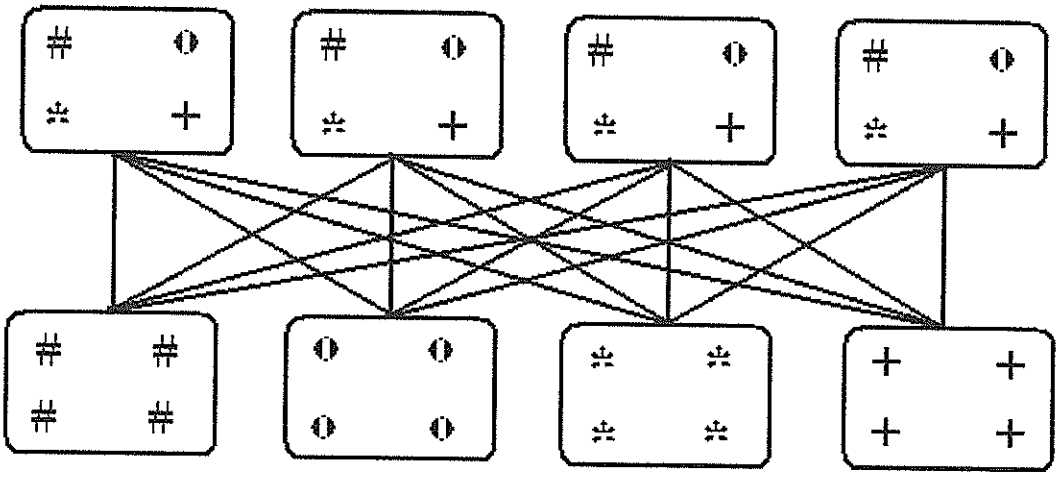

Figure 1. Relation among ... group and expert group in teacing Jigsaw model.

- At] model study of type co-operative of jigsaw , there are group of and expert group" like showed [at] Picture 1. Group come [from], that is student mains group which [is] have student member [to] ably, come [from], immeasurable family background and. Group come [from] to represent aliance from some expert. Expert group, that is student group which consist of different group member which [is] diassignmentkan to study and deepen certain topic [of] and finish assignment-assignment related to its topic to [is] later;then explained to group member come [from]. [All] member of different group, coming in contact with the this topic of [is] same in expert group for the berdiscuss of and study items which [is] diassignmentkan [at] each group member and also assist one another to study the this topic of them. After solution finish, [all] group member later;then return [at] group of and teach [at] friend a group of they what have get at the (time) of meeting [in] expert group.
- Time estimation recognition of software 150 minutes [in] laboratory divided 20 minutes explain congenialitys of General and 130 minutes run practice.

D. **References:**

1. Fowkes, N.D and Mahony, J.J., *An Introduction to Mathematical Modelling*, John Wiley & Sons, 1994.
2. Haberman, R, *Mathematical Models in Mechanical Vibrations, Population Dynamic, and Traffic Flow*, Prentice Hall Inc, Englewood Cliffs, New Jersey 07632, 1971.
3. Murray, J.D, *Mathematical Biology*. Heidelberg Berlin : Springer Verlag, 1993.
4. Widowati and Sutimin, *Buku Ajar Mathematics Modelling*, Jurusan matematika FMIPA UNDIP Semarang, 2007

E. **Scoring Componet and score:**

Assignment I / Kuis	: 10
Middle Exam	: 40
Assignment II / Kuis	: 10
Final Exam	: 40

Note: Assignment I cover items residing in [at] module of[is this topic of expert of and collected [by] [at] Week XII, Assignment II cover items meeting of XIII-XXI and collected [by] [at] Week XXIV..

Scoring Criteria :

1. Score A : 91-100
2. Score AB : 81-90
3. Score B : 71-80
4. Score BC : 61-70
5. Score C : 51-60
6. Score CD : 41-50
7. Score D : 31-40
8. Score E : <30

F. To student with Code B of (baru) permitted to follow semester final exam if minimizing 75% following to lecturing process..

Unit of Lecturing Program
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 13th

A. Instructional Objectives
   1. General
      After finishing the course, students to be able to describe and derive a mathematical model equation of the displacement of the spring mass system in horizontal structure.
   2. Specific
      After studying the material, the students to be able to derive the governing model of displacement of the mass in the horizontal axis. Then the students will develop a capacity to be able to describe the analytical and characteristic behavior considering with the vibration of the solution.

B. Discussion fundamental: Vibration of the horizontal spring mass system without friction

C. Sub Discussion fundamental:
   Vibration of the horizontal spring-mass system.
   Solution of the model equation.

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Describing mechanical vibration	Listening and noting	White board
Presentation	Describing the understanding of physical phenomenon of vibration of the horizontal spring-mass system. Describing the second Newton's and Hooke's Law	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Delivering the next material	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 14th

A. Instructional Objectives
   1. General
      After coursing, the students can be expected to be able to describe and derive a mathematical model equation of the vertical motion of the spring-mass system
   2. Specific
      After studying the material, the students to be able to derive the governing model of motion of a mass attached to spring in vertical. Then the students will develop a capacity to be able to describe the analytical and characteristic behavior considering with the vibration of the solution.

B. Discussion fundamental: Vibration of the vertical spring mass system without friction

C. Sub Discussion fundamental:
   Vibration of the vertical spring-mass system.
   Solution of the model equation.

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Commenting, describing and summarizing the previously material	Listening and noting	White board
Presentation	Explaining the physical phenomenon of the motion of the vertical spring-mass system. Explaining the gravity force effect to derive the governing model of this system.	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Conveying the next information	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 15th

A. Instructional Objectives

1. General
   After coursing, the students will be expected to be able to explain and derive a mathematical model equation of the two masses motion of the spring-mass in a horizontal system
2. Specific
   After studying the material, the students to be able to derive the governing model of two masses motion attached between two springs in horizontal direction. Then the students will develop a capacity to be able to describe the analytical and characteristic behavior considering with the vibration of the solution.

B. Discussion fundamental: Motion of two masses in horizontal spring mass system

C. Sub Discussion fundamental:
   Motion of two masses to two springs in horizontal system.
   Solution of the model equation.

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Commenting, describing and summarizing the previously material	Listening and noting	White board
Presentation	Explaining the physical phenomenon of the motion of two masses for the horizontal spring-mass system. Explaining the motion of two masses to derive the governing model of this system.	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Conveying the next information	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 16th

A. Instructional Objectives

1. General
   After coursing, the students will be expected to be able to explain and derive a mathematical model equation of the mass motion attached by two spring in a horizontal system
2. Specific
   After studying the material, the students to be able to derive the governing model of a mass motion attached between two springs in horizontal direction. Then the students will develop a capacity to be able to describe the analytical and characteristic behavior considering with the vibration of the oscillation.

B. Discussion fundamental: Motion of a particle mass between two springs in horizontal system

C. Sub Discussion fundamental:
   Motion of a particle mass to two springs in horizontal system.
   Solution and analysis of the model equation.

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Repeating, describing and summarizing the previously material	Listening and noting	White board
Presentation	Explaining the physical phenomenon of the motion of mass attached between two springs in horizontal direction. Explaining the motion of mass to derive the governing model of this system.	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Conveying the next information	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 17th

A. Instructional Objectives

1. General

   After following this lecture, the students will be expected to be able to explain and derive a mathematical model equation of the mass motion attached by two parallel springs in a horizontal system

2. Specific

   After studying the material, the students to be able to derive the governing model of a mass motion attached by two parallel springs in horizontal system. Then the students will develop a capacity to be able to describe the analytical and characteristic behavior considering with the vibration of the solution.

B. Discussion fundamental: Motion of a mass attached two parallel and series springs

C. Sub Discussion fundamental:

Motion of a particle mass in parallel springs and series system.
Solution and behavior analysis of the model equation.

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Repeating, describing and summarizing the previously material	Listening and noting	White board
Presentation	Explaining the physical phenomenon of the motion of mass attached in two parallel and series springs in horizontal direction. Explaining the motion of mass to derive the governing model of this system.	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Conveying the next information	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 18th

A. Instructional Objectives

1. General

   After following this lecture, the students will be expected to be able to explain and derive a mathematical model equation of the mass motion by considering the force friction

2. Specific

   After studying the material, the students to be able to explain and derive the governing model of a mass motion of spring mass in horizontal system by considering a friction force. Then the students will develop a capacity to be able to describe the analytical and characteristic behavior considering with the vibration of the solution.

B. Discussion fundamental: a friction force

C. Sub Discussion fundamental:

Motion of a particle mass in parallel springs system.
Solution and behavior analysis of the model equation.

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Repeating, describing and summarizing the previously material	Listening and noting	White board
Presentation	Explaining the physical phenomenon of the motion of mass attached in two parallel springs in horizontal direction. Explaining the motion of mass to derive the governing model of this system.	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Conveying the next information	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 19th

A. Instructional Objectives

1. General
   After following this lecture, the students will be expected to be able to explain and derive a mathematical model equation of the pendulum motion in two dimensions
2. Specific
   After studying the material, the students to be able to explain and derive the governing model of a pendulum motion in Cartesian and polar plane. Then the students will develop a capacity to be able to analytical verify the stability of fixed points in the system.

B. Discussion fundamental: pendulum motion

C. Sub Discussion fundamental:
   Motion of a pendulum with a stiff bar.

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Giving introduction to the material in the lecturing	Listening and noting	White board
Presentation	Explaining the physical phenomenon of the pendulum motion which the mass attached at the end of the stiff. Explaining the motion of a pendulum to derive the governing model of this system.	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Conveying the next information	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 20th

A. Instructional Objectives

1. General
   After following this lecture, the students will be expected to be able to explain a linearization process of a mathematical model equation of the pendulum motion
2. Specific
   After studying the material, the students to be able to describe a linearization method of the pendulum model. Then the students will develop a capacity to be able to analytical verify the stability of fixed points in the system.

B. Discussion fundamental: linearization process

C. Sub Discussion fundamental:
   Taylor expansion of the model equation of the pendulum motion.
   Linearization process.

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Reviewing the previously lecturing.	Listening and noting	White board
Presentation	- Explaining Taylor expansion of the pendulum model equation. - Linearization process of the model equation to Taylor expansion to obtain a linearized form. - Explaining the motion of a linearized pendulum model.	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Conveying the next information	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 21th

A. Instructional Objectives

1. General
   After following this lecture, the students will be expected to be able to analyze the behavior of the system and explain a linearization process of a mathematical model equation of the pendulum motion
2. Specific
   After studying the material, the students have to be able to describe a linearization method of the pendulum model. Then the students will develop a capacity to be able to analytical verify the stability of fixed points in the system.

B. Discussion fundamental: linearization process

C. Sub Discussion fundamental:

- Taylor expansion of the model equation of the pendulum motion.
- Linearization process.

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Reviewing the previously lecturing.	Listening and noting	White board
Presentation	- Explaining Taylor expansion of the pendulum model equation. - Linearization process of the model equation to Taylor expansion to obtain a linearized form. - Explaining the motion of a linearized pendulum model.	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Conveying the next information	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 22th

A. Instructional Objectives

1. General
   After following this lecture, the students will be expected to be able to analyze the conservation of energy.
2. Specific
   After lecturing, the students will be expected to be able to explain the conservation of energy of the spring mass system and pendulum system.

B. Discussion fundamental: conservation of energy

C. Sub Discussion fundamental:

- Kinetic energy
- Potential energy

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Reviewing the previously lecturing.	Listening and noting	White board
Presentation	- Explaining the formulation of kinetic and potential energy. - Explaining the concept of the conserved system	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Conveying the next information	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 23th

A. Instructional Objectives

1. General
   After following this lecture, the students will be expected to be able to analyze and explain the principle of the conservation of energy.
2. Specific
   After lecturing, the students will be expected to be able to explain the behavior of the system based on the principle of the conservation of energy of the spring mass system and pendulum system.

B. Discussion fundamental: stability of the system

C. Sub Discussion fundamental:

- Stability analysis using the concept of the conservation of energy.
- Stability analysis of nonlinear system.

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Reviewing, summarizing the previously lecturing.	Listening and noting	White board
Presentation	- Explaining behavior of the motion of nonlinear system. - Determining stability of the nonlinear equation.	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Conveying the next information	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 24th

A. Instructional Objectives

1. General
   After following this lecture, the students will be expected to be able to analyze and depict the curve and phase plain of the energy equation.
2. Specific
   After lecturing, the students will be expected to be able:
   - to analyze and depict such as; total energy, kinetic and potential energy of the system.
   - to analyze behavior the system based on the phase plane of the energy equation.

B. Discussion fundamental: Energy curve

C. Sub Discussion fundamental:
   - Kinetic energy curve
   - Potential energy curve.
   - Stability analysis of nonlinear system.

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Reviewing, summarizing the previously lecturing.	Listening and noting	White board
Presentation	- Explaining and depicting the kinetic, potential and total energy. - Explaining behavior of the motion - Determining stability of the nonlinear motion, equation.	Noting, discussing and working assignment	OHP and white board
Closing	- Giving self-supporting assignment to solve the governing model - Conveying the next information	Working and discussing	Note books and white board

Unit of Lecturing Program (
(SAP)

Course title : Mathematics Modeling
Course code : MAT 324
Credit : 4
Meeting Time : 1 x 100 minutes
Meeting : 25th

A. Instructional Objectives
   1. General
      After following this lecture, the students will be expected to be able to explain the characterization of behavior of the pendulum motion.
   2. Specific
      After lecturing, the students will be expected to be able:
      - to explain behavior the pendulum system based on the energy phase plane.
      - to depict the curve of the pendulum system in phase plane

B. Discussion fundamental: phase plane of pendulum system

C. Sub Discussion fundamental:
   - Qualitative behavior of a nonlinear oscillator
   - Phase plane trajectory of pendulum system

D. Teaching -Learning Activity:

Stages	Lecture Activity	Students Activity	Media & Tools
Introduction	Reviewing, summarizing the previously lecturing.	Listening and noting	White board
Presentation	- Explaining and depicting the kinetic, potential and total energy. - Explaining behavior of the pendulum motion	Noting, discussing and working assignment	OHP and white board
Closing	- Discussing with the students - Giving the information for test	Working and discussing	Note books and white board