# GBBP & SAP
# MK PILIHAN

**KONSTRUKSI, PERANCANGAN & MANUFAKTUR**


## KURIKULUM
## JURUSAN TEKNIK MESIN
## FAKULTAS TEKNIK – UNDIP
## Tahun 2007

# BASIC RULE OF STUDY PROGRAM

MAJOR SUBJECT : **CONTACT MECHANIC**
CODE NUMBER/CREDIT : TKM-475/2
DESCRIPSION : The course studies about contact mechanics bases and it is continuation course at mechanical engineering. The application of this course at industrial world and also daily custom are hardly many. Lecturing will be started with review knowledge about kinematics bases and mechanics. And then student will be supplied with knowledge about elastic contact with line encumbering type (line loading). Various force types and traction either centrally and also distribution will be studied in complete. The same solution will be continued for point encumbering type (point loading). Besides, contact type analysis that the most popular is Hertz contact also will be given.
Then student introduced at surface roughness concept and contact for harsh surface because this are very often met at application. Case study about contact mechanics trouble-shooting and new development in a world will be passed at the end sessions in this course, so student is able to increase her horizon wide at applying of science and contact mechanics technology.

INSTRUKSIONAL OF GENERAL PURPOSE: Having completed these course students can apply, elaborates and finalizes problems relating to contact mechanics. So they are able to design reliable and optimal mechanic system.

| NO | SPRESIFIC INSTRUCTIONAL PURPOSE | MAJOR SUBJECT PRINCIPAL | SUB MAJOR SUBJECT PRINCIPAL | TIME ESTIMATE (MENIT) | TEACHING METHOD | SOFT SKILL ABILITY | REFERENCE SOURCH |
|---|---|---|---|---|---|---|---|
| 1 | Student comprehends development history of contact mechanics and daily application. | Introduction | History of contact mechanics, nature phenomenon as result of contact mechanics, example application in the newest engineering world and developments | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Student can explain case daily phenomenon. | Book 1,2,3,4 chapter 4 |
| 2 | Comprehend impulse, force, traction and type at contact between two surfaces. | Motion and force contact point | Reference framework, relative motion at surface, force contact point, surface traction | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh kinematics science and dynamics | Book 1 chapter 1 |
| 3 | Comprehends elastic half-space concept, strain, strain | Elastic contact for line load | Concept elastic half-space, normal force centrally, | 100 | Kuliah mimbar dengan alat bantu video | Refresh mechanics | Book 1 chapter 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | and displacement happened as result of line contact load for centrally normal load and centrally tangential load. | | tangential force centrally | | proyektor, OHP dan papan tulis | | |
| 4 | Understands strain, strain and displacement happened as result of lines contact load for normal traction load and tangential and uniform distribution traction load. | Elastic contact for line load | Normal traction and distribution tangential, traction is uniform distribution. | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh mechanics | Book 1 chapter 2 |
| 5 | Understands strain, strain and displacement happened as result of lines contact load for distribution traction load by triangle; comprehends phenomenon if displacement as variable known. | Elastic contact for line load | Triangle of traction distribution, transfer specific at load area | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh mechanics | Book 1 chapter 2 |
| 6 | Comprehends displacement and pressure happened as result of indentation by flat rigid punched; comprehends strain and displacement for parallel traction load to y-axis. | Elastic contact for line load | Indentation by flat rigid punched traction of y-axis parallel. | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh mechanics | Book 1 chapter 2 |
| 7 | Understands approach with potential Boussinesq ( 1885) and Cerruti ( 1882) theory to determine strain and displacement happened as result of load | Elastic contact for load point | Potential Function Boussinesq and Cerruti, normal force centrally. | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh mathematics science | Book 1 chapter 3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | of cube point and the application at centrally normal load. | | | | | | |
| 8 | Middle Examination of Semester (UTS) | Meeting Matter of I up to VII | | 120 | | | |
| 9 | Comprehends strain and displacement happened as result of load point contact for pressure field at district polygon and circular. | Elastic contact for load point | Pressure at polygon area, Pressure at circle area | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh mechanics | Book 1 chapter 4 |
| 10 | Comprehends strain and displacement happened as result of load point contact for pressure field at elliptical district and centrally force tangential. | Elastic contact for load point | Pressure at ellipse area, tangential force centrally | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh mechanics | Book 1 chapter 3 |
| 11 | Comprehends displacement happened as result of load point contact for tangential traction at elliptical district and circle, traction axis-symmetric, and twist payload. | Elastic contact for load point | Tangential traction at elliptical and circle area, traction axis-symmetric, torsion burden. | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh mechanics | Book 1 chapter 3 |
| 12 | Understand substance of contact geometry smooth non-conformal and important variables in analyzing contact mechanics | Hertzian Contact | Object geometry smooth non-conformal. | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh mechanics | Book 1 chapter 4 |
| 13 | Understand idea basic of Hertz about contact mechanics from mathematical side and physical. | Hertzian Contact | Hertzian contact Theory | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh mathematics science and physics | Book 1 chapter 4 |

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|---|---|---|---|---|---|---|---|
| 14 | Understand actually surface geometry in detail scale (micro). | Surface roughness | Rough surface characters, contact actual and which seen. | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh solid goods physics | Book 1 chapter 13 |
| 15 | Can analyze contact mechanics at actual substance (never surface of substance have really smooth). | Surface roughness | Wave surface contact, contacts inter- nominal flat surfaces, contact elastic curved rough surface. | 100 | Kuliah mimbar dengan alat bantu video proyektor, OHP dan papan tulis | Refresh mechanics | Book 1 chapter 13 |
| 16 | Final Exam Semester (UAS) | Meeting Matter of IX up to XV | | 120 | | | |

REFERENCE BOOKS:


1. Jonhson, K.L., *Contact Mechanics*, Cambridge University Press, Cambridge, 1985.
2. Fischer-Cripps, A.C., *Introduction to Contact Mechanics*, Springer-Verlag Inc., New York, 2000.
3. Goryacheva, I.G, *Contact Mechanics in Tribology*, Kluwer Academic Publishers, London, 1998.
4. Journal: *ASME Journal of Tribology, Tribology Letters, WEAR, Tribology International, TriboTest., ASME Journal of Applied Mechanics, International Journal of Solid and Structure.*

# SET OF EVENT OF STUDY (SAP)

MAJOR SUBJECT TITLE : **CONTACT MECHANIC**
SUBJECT TITLE CODE : TKM-475
SKS : 2
MEETING TIME : 100 MINUT
MEETING TO : I

A. PURPOSE OF INSTRUKSIONAL

**1.GENERAL** : Having completed this course student can apply, elaborates and finalizes problems relating to contact mechanics so they can design reliable and optimal mechanic system.

**2.SPECIAL** : Student comprehends history development of contact mechanics and application at daily activity

**B.PERFORMANCE SOFT SKILL** : Student can explain daily case phenomenon.

**C. STUDY METHOD** : presentation course by projector video, OHP and panel writes

**D. DISCUSSION FUNDAMENTAL** : introduction about contact mechanics

**E. DISCUSSION FUNDAMENTAL SUB** : History of contact mechanics, nature phenomenon as result of contact mechanics,.

**F. SCHOOL ACTIVITY**

| NO | STEP | TIME (MINUTE) | TEACHING ACTIVITY | STUDENT ACTIVITY | MEDIAN AND STUDY EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 5 | Submits lecturing agenda | LISTENING | Listens Projector video, OHP and blackboard |
| 2 | PRESENTATION | 70 | Submits and explains teaching Major subject | LISTENING | Listens Projector video, OHP and blackboard |
| 3 | CONCLUSION | 25 | Discussion and gives training | DISCUSION AND EXERCISE | Listens Projector video, OHP and blackboard |

G. EVALUATION : THE RESULT OF DISCUSION AND EXERCISE

H. BIBLIOGRAPHY :


1. Jonhson, K.L., *Contact Mechanics*, Cambridge University Press, Cambridge, 1985.
2. Fischer-Cripps, A.C., *Introduction to Contact Mechanics*, Springer-Verlag Inc., New York, 2000.
3. Goryacheva, I.G, *Contact Mechanics in Tribology*, Kluwer Academic Publishers, London, 1998.
4. Journal: *ASME Journal of Tribology, Tribology Letters, WEAR, Tribology International, TriboTest., ASME Journal of Applied Mechanics, International Journal of Solid and Structure.*


Catatan:
Pertemuan ke-II sampai dengan Pertemuan ke-XVI SAP nya sama dengan perbedaan pada tujuan instruksional dan kepustakaan seperti yang termaktub pada Garis-Garis Besar Program Pembelajaran (GBPP).

# COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Short description : This course is an optional course, FEM is one of numerical method, the ability to integrated with CAD software makes FEM used for analyzing engineering problem. In this course, student learn the procedure to analyze structure cases using FEM
General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model

| No | SPESIFIC OBJECTIVE | MAIN COURSE DESCRIPTION | SUB COURSE DESCRIPTION | TIME ESTIMATION (MENIT) | LEARNING METHOD | DESIRABLE STUDENT COMPETENCIES | TEXT BOOK SOURCE |
|---|---|---|---|---|---|---|---|
| 1 | Student can understand FEM roles in modern engineering<br>Student can understand bar and spring element application | 1.Introduction to FEM and its application<br>2.Spring and bar stiffness matrix | 1.FEM procedure and application<br>2.Making Local and Global matrix Stiffness for spring element | 100 | Presentation, Question and Answer, Problem exercise | Student can understand FEM roles in modern engineering<br>Student can understand bar and spring element application | -Ref 1, chap 1-2<br>-Ref 2, Chap 2 |
| 2 | Student can understand and use FEM for truss and bending problem solving | 1.Truss analysis using FEM<br>2.Torque element | 1.stiffness matrix and transformation matrix formulate and looking for its solution<br>2.Making torque stiffness matrix | 100 | Presentation, Question and Answer, Problem exercise | Student can identify other method which can be use for truss engineering | -Ref 2 chap 2 |
| 3 | Student can understand and use FEM for beam problem solving | 1.Beam analysis using FEM | 1. Matrix stiffness formulated and equivalent nodal load on beam element | 100 | Presentation, Question and Answer, Problem exercise | Student can identify other method which can be use for truss engineering | -Ref 1, chap 5<br>-Ref 2 Chap 3 |
| 4 | Student can understand and use FEM for structure and grid problem solving | 1.Plane frame analysis using FEM<br>2.Grid analysis | 1. Matrix stiffness and tranformation formulated for Inclined supports on | 100 | Presentation, Question and Answer, Problem | Student can identify other method which can be use for structure and | -Ref 1, Chap 6 |

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| | | using FEM | truss cases<br>2. Matrix stiffness formulated and looking for solution on grid element | | exercise | grid engineering | |
| 5 | Student can understand and use FEM for general frame problem solving | 1.general frame element | 1. Matrix stiffness formulated and boundary condition for Truss, torque, beam, plane frame and grid element | 100 | Presentation, Question and Answer, Problem exercise | Student can identify other method which can be use for general frame analysis | -Ref 5 Chap 9 |
| 6 | | MID EXAM | | | | | --- |
| 7 | Student can understand stress and strain approached on 2D cases | 1.Stress field equation<br>2.Strain field equation | 1. making stiffness matrix and equation for Linear strain triangle<br>2. equivalent nodal load formulated for body and surface force | 100 | Presentation, Question and Answer, Problem exercise | Student can understand the use of real cases moderation into simple way so it make it easy to solve | -Ref 1, chap 7<br>-Ref 2, Chap 2 |
| 8 | Student can understand LST element application in 2D analysis | Linear-Strain Triangle Elements (LST) | 1. making global matrix stiffness and equation for Linear strain triangle element | 100 | Presentation, Question and Answer, Problem exercise | Student able to descript 2D element | -Ref 1, chap 9<br>-Ref 3, chap 2 |
| 9 | Student can understand axisymetric element and its use | Axisymetric element | 1. Stiffness matrix element formulated<br>2. Looking for solution on Axisymetric Pressure Vessel | 100 | Presentation, Question and Answer, Problem exercise | Student can understand the use of real cases moderation into simple way so it make it easy to solve | -Ref 1, Chap 10 |
| 10 | Student can understand isoparametric element and its use | Isoparametric element | 1. Isoparametric formulated for Bar Element dan Rectangular Plane Stress Element<br>2. Matrix stiffness calculation using Gaussian Quadrature | 100 | Presentation, Question and Answer, Problem exercise | Student can understand the use of real cases moderation into simple way so it make it easy to solve | -Ref 1, chap 11<br>-Ref 3, Chap 3 |
| 11 | Student can understand the use of FEM on 3D cases | 3 Dimension stress analysis | 1. Making Tetrahedral stiffness element matrix | 100 | Presentation, Question and | Student can understand the use of real cases | -Ref 1, Chap 12 |

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| | | | 2. isoparametric formulated for making stiffness matrix | | Answer, Problem exercise | moderation into simple way so it make it easy to solve | |
| 12 | Student can understand and make simple procedure FEM program | Computer program for the FEM | 1. Making standard algorithm for FEM program<br>2. Making stiffness matrix algorithm for linear strain triangle | 100 | Presentation, Question and Answer, Problem exercise | Student able to understand FEM integration with computer program | -Ref 1, chap 1,3 |
| 13 | Student can understand the use of FEM software | Software output interpretation (NASTRAN | Software output interpretation | 100 | Presentation, Question and Answer, Problem exercise | Student able to understand FEM integration with computer program | --- |
| 14 | Student can understand FEM implementation for simple structure dynamic cases | Structure dynamic using FEM | Consistent mass matrix formulated<br>Eigenvalue problem | 100 | Presentation, Question and Answer, Problem exercise | Student able to explain structure dynamic using FEM | -Ref 3 Chap 9 |
| 15 | Student can understand FEM implementation for simple 1DOF vibration cases | 1DOF Vibration analysis | Natural frequency and mode shape calculation | 100 | Presentation, Question and Answer, Problem exercise | Student able to explain vibration using FEM | -Ref 4 chap 3 |
| 16 | | FINAL EXAM | | | | | |

Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 1st

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand FEM roles in modern engineering
Student can understand bar and spring element application

B. Desirable student competencies:
Student have motivation to learn engineering field

C. Course Method:
Presentation, Question and Answer, Problem exercise.

D. Main course description:
1.Introduction to FEM and its application
2.Spring and bar stiffness matrix

E. Sub Course description:
1.FEM procedure and application
2.Making Local and Global matrix Stiffness for spring element

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |

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|---|---|---|---|---|---|
| 2 | PRESENTATION | 70 | 1.Introduction to FEM and its application<br>2.Spring and bar stiffness matrix | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 2nd

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand and use FEM for truss and bending problem solving

B. Desirable student competencies:
Student can identify other method which can be use for truss engineering
C. Course Method:
Presentation, Question and Answer, Problem exercise.
D. Main course description:
1.Truss analysis using FEM
2.Torque element
E. Sub Course description:
1.stiffness matrix and transformation matrix formulate and looking for its solution
2.Making torque stiffness matrix
F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |

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|---|---|---|---|---|---|
| 2 | PRESENTATION | 70 | 1.Truss analysis using FEM<br>2.Torque element | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 3rd

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand and use FEM for beam problem solving

B. Desirable student competencies:
Student can identify other method which can be use for truss engineering
C. Course Method:
Presentation, Question and Answer, Problem exercise.
D. Main course description:
1.Beam analysis using FEM

E. Sub Course description:
1. Matrix stiffness formulated and equivalent nodal load on beam element
F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | 1.Beam analysis using FEM | Paying attention | LCD |

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|---|---|---|---|---|---|
| | | | | Write important material<br>Problem exercise<br>Asking and suggesting | White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 4th

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand and use FEM for structure and grid problem solving

B. Desirable student competencies:
Student can identify other method which can be use for structure and grid engineering
C. Course Method:
Presentation, Question and Answer, Problem exercise.
D. Main course description:
1.Plane frame analysis using FEM
2.Grid analysis using FEM
E. Sub Course description:
1. Matrix stiffness and tranformation formulated for Inclined supports on truss cases
2. Matrix stiffness formulated and looking for solution on grid element
F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |

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|---|---|---|---|---|---|
| 2 | PRESENTATION | 70 | 1.Plane frame analysis using FEM<br>2.Grid analysis using FEM | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 5th

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand and use FEM for general frame problem solving

B. Desirable student competencies:
Student can identify other method which can be use for general frame analysis
C. Course Method:
Presentation, Question and Answer, Problem exercise.
D. Main course description:
1.general frame element
E. Sub Course description:
1. Matrix stiffness formulated and boundary condition for Truss, torque, beam, plane frame and grid element
F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | General frame element | Paying attention<br>Write important material | LCD<br>White board |

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| | | | | Problem exercise<br>Asking and suggesting | Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 6th

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student able to integrate all five course material

B. Desirable student competencies:
Student able to integrate problems related to 1D element using FEM
C. Course Method:
Presentation, Question and Answer, Problem exercise.
D. Main course description:
All corse material 1 to 5
E. Sub Course description:
-
F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | All corse material 1 to 5 | Paying attention<br>Write important material | LCD<br>White board |

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|---|---|---|---|---|---|
| | | | | Problem exercise<br>Asking and suggesting | Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 7th

A. Course Objective
   1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
   2. Specific Objective : Student can understand stress and strain approached on 2D cases

B. Desirable student competencies:
   Student can understand the use of real cases moderation into simple way so it make it easy to solve

C. Course Method:
   Presentation, Question and Answer, Problem exercise.

D. Main course description:
   1.Stress field equation
   2.Strain field equation

E. Sub Course description:
   1. making stiffness matrix and equation for Linear strain triangle
   2. equivalent nodal load formulated for body and surface force

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | 1.Stress field equation | Paying attention | LCD |

| | | | | | |
|---|---|---|---|---|---|
| | | | 2.Strain field equation | Write important material<br>Problem exercise<br>Asking and suggesting | White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

## STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 8th

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand LST element application in 2D analysis

B. Desirable student competencies:
Student able to descript 2D element

C. Course Method:
Presentation, Question and Answer, Problem exercise.

D. Main course description:
Linear-Strain Triangle Elements (LST)

E. Sub Course description:
1. making global matrix stiffness and equation for Linear strain triangle element

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Linear-Strain Triangle Elements (LST) | Paying attention<br>Write important material | LCD<br>White board |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Problem exercise<br>Asking and suggesting | Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 9th

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand axisymetric element and its use

B. Desirable student competencies:
Student can understand the use of real cases moderation into simple way so it make it easy to solve

C. Course Method:
Presentation, Question and Answer, Problem exercise.

D. Main course description:
Axisymetric element

E. Sub Course description:
1. Stiffness matrix element formulated
2. Looking for solution on Axisymetric Pressure Vessel

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Axisymetric element | Paying attention | LCD |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Write important material<br>Problem exercise<br>Asking and suggesting | White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : $10^{th}$

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand isoparametric element and its use

B. Desirable student competencies:
Student can understand the use of real cases moderation into simple way so it make it easy to solve

C. Course Method:
Presentation, Question and Answer, Problem exercise.

D. Main course description:
Isoparametric element

E. Sub Course description:
1. Isoparametric formulated for Bar Element dan Rectangular Plane Stress Element
2. Matrix stiffness calculation using Gaussian Quadrature

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Isoparametric element | Paying attention<br>Write important material | LCD<br>White board |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Problem exercise<br>Asking and suggesting | Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 11th

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand the use of FEM on 3D cases

B. Desirable student competencies:
Student can understand the use of real cases moderation into simple way so it make it easy to solve

C. Course Method:
Presentation, Question and Answer, Problem exercise.

D. Main course description:
3 Dimension stress analysis

E. Sub Course description:
1. Making Tetrahedral stiffness element matrix
2. isoparametric formulated for making stiffness matrix

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | 3 Dimension stress analysis | Paying attention<br>Write important material | LCD<br>White board |

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|---|---|---|---|---|---|
| | | | | Problem exercise<br>Asking and suggesting | Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 12th

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand and make simple procedure FEM program

B. Desirable student competencies:
Student able to understand FEM integration with computer program

C. Course Method:
Presentation, Question and Answer, Problem exercise.

D. Main course description:
Computer program for the FEM

E. Sub Course description:
1. Making standard algorithm for FEM program
2. Making stiffness matrix algorithm for linear strain triangle

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Computer program for the FEM | Paying attention<br>Write important material | LCD<br>White board |

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|---|---|---|---|---|---|
| | | | | Problem exercise<br>Asking and suggesting | Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 13th

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand the use of FEM software

B. Desirable student competencies:
Student able to understand FEM integration with computer program

C. Course Method:
Presentation, Question and Answer, Problem exercise.

D. Main course description:
NASTRAN software demos

E. Sub Course description:
Software output interpretation

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | NASTRAN software demos | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |

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|---|---|---|---|---|---|
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 14th

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand FEM implementation for simple structure dynamic cases

B. Desirable student competencies:
Student able to explain structure dynamic using FEM
C. Course Method:
Presentation, Question and Answer, Problem exercise.
D. Main course description:
Structure dynamic using FEM
E. Sub Course description:
Consistent mass matrix formulated
Eigenvalue problem
F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Structure dynamic using FEM | Paying attention | LCD |

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| | | | | Write important material<br>Problem exercise<br>Asking and suggesting | White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# STANDART COURSE OUTLINE

Subject : **FINITE ELEMENT METHOD**
Subject Code : TKM 477
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 15th

A. Course Objective
1. General Objective : Student have the ability to know and understand structure modeling using FEM which consist of choosing finite element, nodal degree of freedom, element discretitation also able to solve it based on standard procedure which has been set for all finite element model
2. Specific Objective : Student can understand FEM implementation for simple 1DOF vibration cases

B. Desirable student competencies:
Student able to explain vibration using FEM

C. Course Method:
Presentation, Question and Answer, Problem exercise.

D. Main course description:
1DOF Vibration analysis

E. Sub Course description:
Natural frequency and mode shape calculation

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | 1DOF Vibration analysis | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |

| | | | | | |
|---|---|---|---|---|---|
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giving homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book


1. Logan, Daryl L., *A First Course in The Finite Element Method*, Second Edition, PWS-KENT Publishing Company, Boston, 1992
2. Huebner, Kenneth H., *The Finite Element Method for Engineers*, Second Edition, John Wiley & Sons, New York, 1975
3. Weaver, William Jr. and Johnston, Paul R., *Finite Element for Structural Analysis*, Prentice-Hall Inc., New Jersey, 1978
4. Weaver, William Jr. and Johnston, Paul R., *Structural Dynamics by Finite Elements*, Prentice-Hall Inc., New Jersey, 1987
5. Krishnamoorty., *Finite Element Method*, Second Edition, Prentice-Hall Inc, New Delhi, 1974

# GARIS-GARIS BESAR PROGRAM PEMBELAJARAN (GBPP)

MAJOR SUBJECT : **PRESSURE VESSEL DESIGN**
CODE NUMBER/CREDIT : TKM-479/2
DESCRIPTION : The course studies about scheme bases of pressure vessel and is applied course at mechanical engineering. The application of this course at industrial world and also daily custom are hardly many. Process industry is including at high risk category so that standard or CODE released by association of international credible profession, for example ASME (American Society for Mechanical Engineers), made main reference. Matter in this course also refers to code-code which is formal is used international world, that is ASME CODE Section VIII Division I about Pressure Vessel Design. Analytically analysis is also introduced, because basically result from CODE is analyzing either analytic and also numeric, then it is settled addition with security and safety factor. Design is started from determination of material, finite loads analyst at supporter elements, for example saddle, bolts and others. Main design is plate thick determination for main canister and close canister. Lasing ring installation for nozzle is also designed at this course. At the end of course will be introduced commercial software. It is applied for pressure vessel scheme. Then student is given task to design manually based on CODE and designs based on software then compares its result. Analysis will be studied together. Student is expected ready to solve pressure vessel scheme problem in industry.

GENERAL INSTRUCTIONAL PURPOSE: Having completed this course student can design analyses and applies scheme science of pressure vessel at industrial world. Until reliable and safe pressure vessel planning are resulted

| NO | SPECIAL INSTRUCTION PURPOSE | MAJOR SUBJECT PRINCIPAL | SUB MAJOR SUBJECT PRINCIPAL | TIME ESTIMATE (MENIT) | TECHING METHOD | SOFTSKILL ABILITY | SOURCE LITERATURE |
|---|---|---|---|---|---|---|---|
| 1 | Student knows definition of standard and code, history of code to pressure vessel, and organization code for ASME Boiler and Pressure Vessels (Pressure vessel) | Introduction | Code and standard; history of code pressure vessel (pressure boat); association of profession ASME organization and ASME Boiler and Pressure Vessels Code | 100 | Presentation course is using projector video, OHP and blackboard. | Student understand about profesion | Book 1-7 |
| 2 | Understands materials applied at design of Pressure vessel, starts from other plate and supporter component until | Pressure vessel materials | General; plate; forgings; castings; pipe and tubes; weld material; material for purpose of especially unclear is identified; | 100 | Presentation course is using projector video, OHP | Preview material engineering and application | Book 1: UG-4 s.d. UG-15 |

| | | | | | | | |
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| | specification of product | | prefabricated or preformed pressure parts; bolts and studs; nuts and washers; rods and bars; products specification. | | and blackboard. | | |
| 3 | Understanding bases design of pressure vessel, for example temperature, design pressure, load, maximum tension permitted, corrosion, etc. | Design | General; fabricate method for combination; combination material; special construction; temperature scheme; pressure scheme; encumbering: maximum tension permitted; castings; corrosion; linings. | 100 | Presentation course is using projector video, OHP and blackboard. | understand basic design | Book 1: UG-16 - UG-26 |
| 4 | Be able to determine thick design a canister that it is receiving internal pressure load. | Design wall thick as result of internal pressure load. | Design of wall thick as result of internal pressure burden: steps. | 100 | Presentation course is using projector video, OHP and blackboard. | Understand standard operation procedur | Book 1: UG-27 |
| 5 | Be able to design minimum thickness from a vessel which receiving external pressure burden.. | Scheme of wall thick as result of internal pressure load | Design wall thick as result internal pressure load: steps. | 100 | Presentation course is using projector video, OHP and blackboard. | Understand standard operation procedur | Book 1: UG-28 |
| 6 | Be able to design lasing ring for vessel as result of external pressure and how to designs pipe applied as | Lasing ring | Lasing ring Vessel as result of external pressure load; lasing ring installation; tubes, and | 100 | Presentation course is using projector | Understand support part | Book 1: UG-29 - UG-31 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | vessel installation. | | pipe when it is applied as tubes or shells. | | video, OHP and blackboard. | | |
| 7 | Be able to design rugged vessel cover receiving flat internal pressure load and closed vessel. | Design of special close vessel 1 | Design of rugged cover vessel and cutting type, accentual burden at concave side; unsteady flat cover and covers. | 100 | Presentation course is using projector video, OHP and blackboard. | Understand standard operation procedur | Book 1: UG-32 & UG-34 |
| 8 | Middle Test of Semester (UTS) | Meeting Matter of I up to VII | | 120 | | | |
| 9 | Be able to design kinds of vessel covers that receiving external pressure load. | Design of special close vessel 2 | Formed heads, pressure on convex eunuch; other types of closure. | 100 | Presentation course is using projector video, OHP and blackboard. | Understand standard operation procedur | Book 1: UG-33 & UG-35 |
| 10 | Be able to design aperture and lasing starts from hole diameter, finite lasing thick, Till how to inspect | Design of nozzle aperture | Openings and reinforcements: Openings in pressure vessels; reinforcement required for openings in shells and formed heads; fluid openings; reinforcement for flat heads; limits and strength of reinforcement; reinforcement of multiple openings; methods of attachments of pipe and nozzle necks to vessel | 100 | Presentation course is using projector video, OHP and blackboard. | Understand standard operation procedur | Book 1: UG-36 s.d. UG-46 |

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|---|---|---|---|---|---|---|---|
| | | | walls; flanges and pipe fittings; nozzle neck thickness; inspection openings. | | | | |
| 11 | Can design other supporter components from pressure vessel such as; staybolts, ligament etc | Design of supporter vessel element | Braced and stayed surfaces; staybolts; location of staybolts; dimensions of staybolts; ligaments; supports; lugs for platforms, ladders, and other attachments to vessel walls. | 100 | Presentation course is using projector video, OHP and blackboard. | Understand standard operation procedur | Book1: UG-47 s.d. UG-55 |
| 12 | Understand pressure vessel manufacturing bases, cutting of plate, Charpy test and heat treatment. | Fabricate | General; cutting plates and other stock; material identification; repair of defects in materials; forming shells sections and heads; permissible out-of-roundness of cylindrical, conical, and spherical shells; tolerance for formed heads; lugs and fitting attachments; holes for screw stays; Charpy impact tests; heat treatment. | 100 | Presentation course is using projector video, OHP and blackboard. | Preview process production science | Book 1: UG-75 s.d. UG-85 |
| 13 | Understand applied method in inspection and examination at pressure vessel. | Testing of Pressure vessel | General; the inspector; access for inspector; inspection of materials; marking on materials; examination of surfaces during fabrication; dimensional check of component parts; | 100 | Presentation course is using projector video, OHP and blackboard. | Preview nondestruction test | Book 1: UG-90 s.d. UG-103 |

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| | | | inspection during fabrication; maximum allowable working pressure; standard hydrostatic test; pneumatic test; proof tests to establish maximum allowable working pressure; test gages; non-destructive testing. | | | | |
| 14 | Understand way of mark is used at pressure vessel like nameplates, data reports etc. | Report making | General; required marking; certificates of authorization and code symbols stamps; methods of marking; nameplates; data reports. | 100 | Presentation course is using projector video, OHP and blackboard. | Understand how to write report | Book1: UG-115 s.d. UG-120 |
| 15 | Recognize commercial software to assist in pressure vessel design. | Demonstration: Pressure boat commercial software. | Pre-processing; processing; and post-processing. | 100 | Presentation course is using projector video, OHP and blackboard. | Understand toolbox design | Software developer company |
| 16 | Semester Final Exam (UAS) | Meeting Matter of IX up to XV | | 120 | | | |

REFERENCE BOOK:


1. *ASME Boiler and Pressure Vessel Code Section VIII Division I*, ASME Publication, New York, 2004.
2. Chattopadhyay, S., *Pressure Vessels: Design and Practice*, CRC Press, Boca Raton, Florida, 2000.
3. Harsokoesoemo, D.H., *Analisa Tegangan Dalam Bejana Tekan*, Lab. Perancangan Mesin ITB, Bandung, 1990.

4. Bednar, H.E., *Pressure Vessel Design Handbook*, Van Nostrand Reinhold Company, New York, 1981.
5. Bickell, M.B. and Ruiz, C., *Pressure Vessel Design and Analysis*, McMilan and Company Ltd., London, 1967.
6. Gill, S.S., *The Stress Analysis of Pressure Vessels and Pressure Vessel Components*, Pergamon press, Oxford, 1970.
7. Journal: *ASME Journal of Pressure Vessel Technology, International Journal of Pressure Vessel and Piping.*

# SET OF EVENT OF STUDY (SAP)

MAJOR SUBJECT TITLE : **PRESSURE VESEL DESIGN**
SUBJECT TITLE CODE : TKM-479
SKS : 2
MEETING TIME : 100 MINUT
MEETING TO : I

A. PURPOSE OF INSTRUKSIONAL

**1.GENERAL** : Having completed this course student can design, analyze and apply study of pressure vessel design at industrial world, to get strong and safety pressure vessel design.

**2.SPECIAL** : Student comprehends standardd and code definition, code history at a pressure vessel and organization code for ASME Boiler and Pressure Vessels.

**B.PERFORMANCE SOFT SKILL** : Student comprehends about profession organizer.

**C. STUDY METHOD** : presentation course by projector video, OHP and panel writes

**D. DISCUSSION FUNDAMENTAL** : introduction about contact mechanics

**E. DISCUSSION FUNDAMENTAL SUB** : History of contact mechanics, nature phenomenon as result of contact mechanics,.

**F. SCHOOL ACTIVITY**

| NO | STEP | TIME (MINUTE) | TEACHING ACTIVITY | STUDENT ACTIVITY | MEDIAN AND STUDY EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 5 | Submits lecturing agenda | LISTENING | Listens Projector video, OHP and blackboard |
| 2 | PRESENTATION | 70 | Submits and explains teaching Major subject | LISTENING | Listens Projector video, OHP and blackboard |
| 3 | CONCLUSION | 25 | Discussion and gives training | DISCUSION AND EXERCISE | Listens Projector video, OHP and blackboard |

G. EVALUATION : THE RESULT OF DISCUSION AND EXERCISE

H. BIBLIOGRAPHY :


1. Jonhson, K.L., *Contact Mechanics*, Cambridge University Press, Cambridge, 1985.
2. Fischer-Cripps, A.C., *Introduction to Contact Mechanics*, Springer-Verlag Inc., New York, 2000.
3. Goryacheva, I.G, *Contact Mechanics in Tribology*, Kluwer Academic Publishers, London, 1998.
4. Journal: *ASME Journal of Tribology, Tribology Letters, WEAR, Tribology International, TriboTest., ASME Journal of Applied Mechanics, International Journal of Solid and Structure.*


Catatan:
Pertemuan ke-II sampai dengan Pertemuan ke-XVI SAP nya sama dengan perbedaan pada tujuan instruksional dan kepustakaan seperti yang termaktub pada Garis-Garis Besar Program Pembelajaran (GBPP).

Subject : **SEMI SOLID METAL FORMING**
Subject Code : TKM 482
Short description : This is an optional course, contains the technology development concerning on manufacturing process which is semi solid metal forming. This technology still develops nowadays and haven't much applicated in industrial field. Inthis course student been given the importance to learn basic concept of engineering and its use, and it is background in developing semi solid metal forming
General Objective : Student Have the ability to understand metal chilling phenomena, engineering use, and technology application on semi solid metal forming also the chance to develop in the future

| No | SPESIFIC OBJECTIVE | MAIN COURSE DESCRIPTION | SUB COURSE DESCRIPTION | TIME ESTIMATION (MENIT) | LEARNING METHOD | DESIRABLE STUDENT COMPETENCIES | TEXT BOOK SOURCE |
|---|---|---|---|---|---|---|---|
| 1 | Student can understand SSF process in general | Introduction to semi-solid metal forming (SSF) | - Review of casting and forging process<br>SSF development in general<br>SSF process | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 1 & 2 |
| 2 | Student have the ability to understand rheolgy on SSF | SSF Rheology | - Examination technique<br>Rhelogy modelling<br>Thixotropy modelling<br>Steady chilled modelling | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 1 & 2 |
| 3 | Student have the ability to understand SSF raw material characteristic | SSF Raw material characteristic | - SSM billet deformation behaviour with high solid fraction<br>Micro structure evolution during billet preparation<br>Micro structure characteristic<br>Particles morphology<br>Particles distribution | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 1 & 2 |
| 4 | Student have the ability to understand SSF raw material characteristic | SSF Raw material characteristic | - Chilled treatment under forced convection<br>Non-dendritic structure forming mechanism<br>Micro structure development during half part of remelting and isotherm detention<br>Micro structure roughness modelling | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 1 & 2 |
| 5 | Student have the ability to repair SSF raw material mechanic behavior through alloy technique | Alloy development for SSF raw material | - Alloy development for SSF process<br>Path for special Alloy<br>Present condition of alloy design<br>Basic consideration for alloy | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 1 & 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Aging hardened potention<br>Cast able behavior<br>SSF rhelogy behavior<br>Basic approach to alloy design | | | | |
| 6 | Student have the ability the relationship between SSF raw material micro structure with mechanical behavior | SSF billet mechanics behavior | - Tensile behavior<br>Fatigue strength<br>Fracture strength<br>Machanics behavior on magnesium alloy | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 1 & 2 |
| 7 | UTS | | | | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | |
| 8 | Student have the ability to identify and understand SSF billet making procedure | SSF billet process technology | - Technology to produce non-dendritic billet<br>Mechanical squealer<br>MHD technique<br>SIMA technique<br>Spray casting<br>Liquidus casting<br>Ultrasonic treatment<br>chemical Refinement<br>Other method | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 1 & 2 |
| 9 | Student have the ability to identify and understand manufacturing method using SSF billet | Forming tehnology using SSF technique | - Rheocasting<br>Thixoforming<br>Thixomoulding<br>Rheomoulding | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 1 & 2 |
| 10 | Student have the ability to understand SSF development in the future | SSF development in the future | 1.Process development<br>2.Making procedure of globular<br>3.Alloy development for SSF<br>4.SSF porridge rheology<br>5.Material micro structure characteristic | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 1 & 2 |
| 11 | Student have the ability to understand SSF application in industry | Industrial application | Making component using SSF application | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 1 & 2 |
| 12 | Student have the ability to identify the chance of using material in SS condition | Raw material usage on semi solid condition | Other alternative forming process using Semi solid condition | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 1 & 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | development | | SSF | | Answer, Discussion. | motivation to learn new things | |
| 14 | Student have the ability to follow SSF R&D development | R&D SSF | Journal discussion concerning SSF | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 2 |
| 15 | Student have the ability to follow SSF R&D development | R&D SSF | Journal discussion concerning SSF | 100 | Presentation, Question and Answer, Discussion. | Student have the motivation to learn new things | Ref. 2 |
| | | | | | | | |

Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 1st

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student can understand SSF process in general

B. Desirable student competencies:
Student able to integrate nature phenomena and engineering problem

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
Introduction to semi-solid metal forming (SSF)

E. Sub Course description:
Review of casting and forging process
SSF development in general
SSF process

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Introduction to semi-solid metal forming (SSF) | Paying attention<br>Write important material | LCD<br>White board |

| | | | | | |
|---|---|---|---|---|---|
| | | | Review of casting and forging process<br>SSF development in general<br>SSF process | Problem exercise<br>Asking and suggesting | Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 2nd

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to understand rheolgy on SSF

B. Desirable student competencies:
Student have the motivation to learn new things

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
SSF Rheology

E. Sub Course description:
Examination technique
Rhelogy modelling
Thixotropy modelling
Steady chilled modelling

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Rheologi logam semi padat | Paying attention | LCD |

| | | | | | |
|---|---|---|---|---|---|
| | | | Examination technique<br>Rhelogy modelling<br>Thixotropy modelling<br>Steady chilled modelling | Write important material<br>Problem exercise<br>Asking and suggesting | White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 3rd

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to understand SSF raw material characteristic

B. Desirable student competencies:
Student have the motivation to learn new things

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
SSF Raw material characteristic

E. Sub Course description:
SSM billet deformation behaviour with high solid fraction
Micro structure evolution during billet preparation
Micro structure characteristic
Particles morphology
Particles distribution

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |

| | | | | | |
|---|---|---|---|---|---|
| 2 | PRESENTATION | 70 | SSF Raw material<br>SSM billet deformation behaviour with high solid fraction<br>Micro structure evolution during billet preparation<br>Micro structure characteristic<br>Particles morphology<br>Particles distribution | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 4th

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to understand SSF raw material characteristic

B. Desirable student competencies:
Student have the motivation to learn new things

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
SSF Raw material characteristic

E. Sub Course description:
Chilled treatment under forced convection
Non-dendritic structure forming mechanism
Micro structure development during half part of remelting and isotherm detention
Micro structure roughness modelling

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |

| | | | | | |
|---|---|---|---|---|---|
| 2 | PRESENTATION | 70 | SSF Raw material<br>Chilled treatment under forced convection<br>Non-dendritic structure forming mechanism<br>Micro structure development during half part of remelting and isotherm detention<br>Micro structure roughness modelling | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 5th

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to repair SSF raw material mechanic behavior through alloy technique

B. Desirable student competencies:
Student have the motivation to learn new things

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
Alloy development for SSF raw material

E. Sub Course description:
Alloy development for SSF process
Path for special Alloy
Present condition of alloy design
Basic consideration for alloy development
Aging hardened potention
Cast able behavior
SSF rhelogy behavior
Basic approach to alloy design

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| | | | | | AVAILABLE |
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Alloy development for SSF process<br>Path for special Alloy<br>Present condition of alloy design<br>Basic consideration for alloy development<br>Aging hardened potention<br>Cast able behavior<br>SSF rhelogy behavior<br>Basic approach to alloy design | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate

2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 6th

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability the relationship between SSF raw material micro structure with mechanics behavior

B. Desirable student competencies:
Student able to integrate they understanding in engineering field

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
SSF billet mechanics behavior

E. Sub Course description:
Tensile behavior
Fatigue strength
Fracture strength
Machanics behavior on magnesium alloy

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |

| | | | | | |
|---|---|---|---|---|---|
| 2 | PRESENTATION | 70 | 1.Tensile behavior<br>2.Fatigue strength<br>3.Fracture strength<br>4.Mechanics behavior on magnesium alloy | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giveing homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 8th

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to identify and understand SSF billet making procedure

B. Desirable student competencies:
Student able to integrate they understanding in engineering field

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
SSF billet process technology

E. Sub Course description:
Technology to produce non-dendritic billet
Mechanical squealer
MHD technique
SIMA technique
Spray casting
Liquidus casting
Ultrasonic treatment
chemical Refinement
Other method

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | 1. Technology to produce non-dendritic billet<br>2.Mechanical squealer<br>3.MHD technique<br>4.SIMA technique<br>5.Spray casting<br>6.Liquidus casting<br>7.Ultrasonic treatment<br>8.chemical Refinement<br>9.Other method | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giving homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 9th

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to identify and understand manufacturing method using SSF billet

B. Desirable student competencies:
Student able to integrate they understanding in engineering field

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
Forming tehnology using SSF technique

E. Sub Course description:
Rheocasting
Thixoforming
Thixomoulding
Rheomoulding

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |

| | | | | | |
|---|---|---|---|---|---|
| 2 | PRESENTATION | 70 | 1. Rheocasting<br>2.Thixoforming<br>3.Thixomoulding<br>4.Rheomoulding | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giving homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 10th

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to identify and understand manufacturing method using SSF billet

B. Desirable student competencies:
Student able to integrate they understanding in engineering field

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
SSF development in the future

E. Sub Course description:
Rheocasting
Thixoforming
Thixomoulding
Rheomoulding

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |

| | | | | | |
|---|---|---|---|---|---|
| 2 | PRESENTATION | 70 | 1.Process development<br>2.Making procedure of globular<br>3.Alloy development for SSF<br>4.SSF porridge rheology<br>5.Material micro structure characteristic | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giving homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 11th

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to understand SSF application in industry

B. Desirable student competencies:
Student able to integrate they understanding in engineering field

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
Industrial application

E. Sub Course description:
Making component using SSF application

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | 1 Making component using<br>2. SSF application | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |

| | | | | | |
|---|---|---|---|---|---|
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giving homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 12th

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to identify the chance of using material in SS condition

B. Desirable student competencies:
Student have the motivation to learn new things

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
Raw material usage on semi solid condition

E. Sub Course description:
Other alternative forming process using Semi solid condition

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Other alternative forming process using Semi solid condition | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |

| | | | | | |
|---|---|---|---|---|---|
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giving homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 13th

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to follow SSF R&D development

B. Desirable student competencies:
Student have the motivation to learn new things

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
R&D SSF

E. Sub Course description:
Journal discussion concerning SSF

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Journal discussion concerning SSF | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |

| | | | | | |
|---|---|---|---|---|---|
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giving homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 14th

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to follow SSF R&D development

B. Desirable student competencies:
Student hjave the motivation to learn new things

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
R&D SSF

E. Sub Course description:
Journal discussion concerning SSF

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Journal discussion concerning SSF | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |

| | | | | | |
|---|---|---|---|---|---|
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giving homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

# STANDART COURSE OUTLINE

Subject : **SEMI-SOLID METAL FORMING**
Subject Code : TKM
Subject Credit : 2
Class schedule : 2 x 50 minutes
Lecture : 15th

A. Course Objective
1. General Objective : Student have the ability to understand chilled metal phenomena, engineering usage and the application of semi-solid metal forming also the opportunity and obstacle in the future
2. Specific Objective : Student have the ability to follow SSF R&D development

B. Desirable student competencies:
Student hjave the motivation to learn new things

C. Course Method:
Presentation, Question and Answer, Discussion.

D. Main course description:
R&D SSF

E. Sub Course description:
Journal discussion concerning SSF

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | 1. explaining course material<br>2. assessment method | Paying attention<br>Asking and suggesting | LCD<br>White board<br>Color marker |
| 2 | PRESENTATION | 70 | Journal discussion concerning SSF | Paying attention<br>Write important material<br>Problem exercise<br>Asking and suggesting | LCD<br>White board<br>Color marker |

| | | | | | |
|---|---|---|---|---|---|
| 3 | CLOSING | 15 | 1. giving course conclusion<br>2. giving homework<br>3. next week course illustration | Paying attention<br>Answering question<br>Giving homework | LCD<br>White board<br>Color marker |

G. Method of assessment

Random question to student during classes

H. Text Book

1. Satrijo,D; Suprihanto, S; "Introduction to Semi-Solid Metal Forming", Course dictate
2. Relevan article on journal related to SSF

## DIRECTION OF TEACHING PROGRAM

SUBJECT TITLE : ROBOTICS I

INDEX NUMBER : TKM-483/2

BRIEF DESCRIPTION : This subject introduces about all aspects in robotics science including several aspects are mechanics, censor, actuator, control and software. Beside that, this subject give explanation to students about applications of robotics science that is applied in designing a robot for industry.

GENERAL INSTRUCTION PURPOSES : In order to students understand basic concepts in designing a robot for industry.

| SPECIAL INTRUCTION PORPOSES | MAIN SUBJECTS | SUB MAIN SUBJECTS | TIME ESTIMATION (MINUTES) | TEACHING METHODS | SOFT SKILL CAPABILITY | REFERENCE SOURCES |
|---|---|---|---|---|---|---|
| Know and understand about kind of robots | Introduction | Definition and clasifications of robot, robot development, robot structurs, and robot configurations | 120 | Attendance, discusion | Can distinct kind of robots that is applied in all life aspects | 1 |
| Know matemathic models for description space and orientation in 2 and 3 dimension | Description about space and its transformation | Coordinat system, Position Description, Orientation and Frame, Frame to Frame Mapping, Operator Translation, Rotation and Transformation, Summary Interpretation Matrix Transformation | 120 | Attendance, discusion and practices | Can use MATLAB software in solving matrix problem and vector related to position description and orientations | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Homogen | | | | |
| Understand about description of tranformation movement from robot frame | Description about space and its transformation | Arithmetic Transformation Other several representations | 120 | Attendance, discusion practices and homework | Can solve multiplication of matrixs that show frame transformation | 1 |

**STANDARD COURSE OUTLINE**

**TKM 483 : ROBOTICS I (2 CREDITS)**

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 1
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : The students know and understand kinds of robot and also the development of robot applications
2. SPECIFIC OBJECTIVE : Know and understand kinds of robot

B. SOFT SKILL COMPETENCY : Develop students capability in distinct kinds of robot that is used in all life aspects.

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Introduction

E. SUB COURSE DESCRIPTION` : Definition and classifications of robot, robot development, robot structures, robot configurations

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching about robot definition | Listening | LCD, Whiteboard, toy robot |
| 2 | MAIN LECTURE | 90 | Teaching about robot development, robot structure, robot configurations including Articulated/Revolute/Jointed-arm, silindris, speris/polar and Cartesian/rectangular | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Conclude lecturer and give general description about the next lecturer | Listening | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to explain robot definition and its configuration

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

**STANDARD COURSE OUTLINE**

**TKM 483 : ROBOTICS I (2 CREDITS)**

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 2
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand position description, orientations of robot frame or manipulator

2. SPECIFIC OBJECTIVE : Students know mathematical model to describe position and orientation on 2 and 3 dimensions

B. SOFT SKILL COMPETENCY : Are able to use MATLAB software and solve vector and matrix problems related to position and orientation description

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Space description and its transformation

E. SUB COURSE DESCRIPTION` : Coordinate system, position description, orientation and frame, mapping of frame to frame, translation operator, rotation and transformation, conclude of homogeny transformation matrix interpretations

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching about robot configurations | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about coordinate system, position description and orientation and also explain about frame with its homogeny transformation | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecturer and give general description about the next lecturer | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to do matrix multiple to explain rotation and translation matrix.

H. TEXTBOOK :

1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

**STANDARD COURSE OUTLINE**

**TKM 483 : ROBOTICS I (2 CREDITS)**

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 3
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand position description, orientation of robot frame or manipulator
2. SPECIFIC OBJECTIVE : Students are able to understand description of several method to determine representation of frame

B. SOFT SKILL COMPETENCY : Are able to solve matrix multiple that shows frame transformation

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Space description and its transformations

E. SUB COURSE DESCRIPTION ` : Transformation of arithmetic, some of other orientation representation

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching about rotation and translation operator | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about transformation cluster and others orientation representation like XYZ permanent angle, ZYX Euler angle, ZYZ Euler angle | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecturer and give general descriptions about the next lecturer | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students cam do frame orientati on representation process

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

**STANDARD COURSE OUTLINE**

**TKM 483 : ROBOTICS I (2 CREDITS)**

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 4
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students understand that kinematics is really important in studying robotic science

2. SPECIFIC OBJECTIVE : Students know and understand kinematics concept which is science that explain movement with neglect cause force

B. SOFT SKILL COMPETENCY : Are able to analyze relationship between link and understand basic rule of frame placement

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Kinematics of Manipulator

E. SUB COURSE DESCRIPTION` : Geometry way, Link Description, Description of Link Relationship, Rule of Frame Placement

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Repeating about others orientation representation method | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about link description and its relationship with others link | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecturer and give general explanation about the next lecturer | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to explain about relationship between link

H. TEXTBOOK :

1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed.
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

## STANDARD COURSE OUTLINE

## TKM 483 : ROBOTICS I (2 CREDITS)

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 5
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to show DH parameter of robot

2. SPECIFIC OBJECTIVE : Are able to analyze about manipulator movement geometry to reference coordinate system that shows displacement description in space as time function

B. SOFT SKILL COMPETENCY : Are able to show DH parameter of robot

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Kinematics of Manipulator

E. SUB COURSE DESCRIPTION` : Kinematics of Manipulator, Actuator of Space, Joint Space, and Cartesian Space, Some of Standard Frame Name

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Repeating about relationship description between link | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about forward kinematics that explains base frame transformation to frame end e-efector | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecturer and give general description about the next lecturer | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to do base frame transformation process to end e-efector of robot

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

## STANDARD COURSE OUTLINE

## TKM 483 : ROBOTICS I (2 CREDITS)

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 6
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to explain kinematics inverse of manipulator

2. SPECIFIC OBJECTIVE : Are able to get joint variable if position and orientation of end-efector is known

B. SOFT SKILL COMPETENCY : Are able to calculate joint variable value

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Inverse Kinematics of Manipulator

E. SUB COURSE DESCRIPTION` : Solvability, Manipulator with degree of freedom less than six, Algebra and Geometric Approaching

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Repeating brief about forward kinematics | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about kinematics inverse of manipulator that explain end-efector frame transformation to base frame if end-efector position is known | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecturer and give general description about the next lecturer | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are given problems about calculation of manipulator inverse kinematics

H. TEXTBOOK :

1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

**STANDARD COURSE OUTLINE**

**TKM 483 : ROBOTICS I (2 CREDITS)**

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 7
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to explain inverse kinematics of manipulator

2. SPECIFIC OBJECTIVE : Students are able to solve inverse kinematic probloems with using Pieper method solving

B. SOFT SKILL COMPETENCY : Able to calculate joint variable value with Pieper method

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Inverse Kinematics of Manipulator

E. SUB COURSE DESCRIPTION` : Solving Inverse Kinematics of Manipulator with Pieper Method

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Repeating brief about inverse kinematics | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about solving of inverse kinematics of manipulator with using Pieper method | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecturer and give general description about the next lecturer | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are given problem about inverse kinematics calculation of manipulator and solved by Pieper method

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

**STANDARD COURSE OUTLINE**

**TKM 483 : ROBOTICS I (2 CREDITS)**

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 8
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand about speed and static concept on manipulator

2. SPECIFIC OBJECTIVE : Students are able to understand Jacobian concept about speed o manipulator

B. SOFT SKILL COMPETENCY : Able to calculate angular and linear speed that occur on manipulator link

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Jacobian : Speed and Static Force

E. SUB COURSE DESCRIPTION` : Notation for time position and orientation variation, angular and linear speed for rigid system, link movement from robot, link spreading speed

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Repeating brief about inverse kinematics | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about linear and angular speed that occur on manipulator link | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecturer and give general description about the next lecturer | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to solve problems of linear and angular speed of manipulator link

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

**STANDARD COURSE OUTLINE**

**TKM 483 : ROBOTICS I (2 CREDITS)**

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 9
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand speed and static force concept on manipulator

2. SPECIFIC OBJECTIVE : Able to understand static force concept that occur on manipulator

B. SOFT SKILL COMPETENCY : Able to calculate static force on manipulator link

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Jacobian : Speed and Static Force

E. SUB COURSE DESCRIPTION` : Jacobian, Singularity, Static Force on Manipulator, Jacobian on Force Domain

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Repeating brief about speed of manipulator link | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about singularity and static force that occur on manipulator that spread from based on link to outer link from manipulator | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecturer and give general description about the next lecturer | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to solve problems about calculation of manipulator link static force

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

**STANDARD COURSE OUTLINE**

**TKM 483 : ROBOTICS I (2 CREDITS)**

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 10
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand about dynamic equation to determine joint torsion value

2. SPECIFIC OBJECTIVE : Students are able to understand some method that is used to solve dynamic equation of manipulator such as Newton-Euler method

B. SOFT SKILL COMPETENCY : Able to calculate force and moment value that cause movement of manipulator

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Manipulator Dynamic

E. SUB COURSE DESCRIPTION` : Acceleration of Rigid system speed, Mass Distribution, Newton_-Euler Equation, Iteration of Newton-Euler Dynamic Formula

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Repeating brief about static force of manipulator link | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about manipulator dynamic equation with using Newton-Euler method | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecturer and give general description about the next lecturer | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to solve problems about mass distribution in calculation stage of manipulator dynamic equation

H. TEXTBOOK :

1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

**STANDARD COURSE OUTLINE**

**TKM 483 : ROBOTICS I (2 CREDITS)**

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 11
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand about dynamic equation to determine joint torsion value

2. SPECIFIC OBJECTIVE : Students are able to understand dynamic equation structure of manipulator as election basic of actuator from manipulator itself

B. SOFT SKILL COMPETENCY : Able to determine joint torsion value that will be choosed on actuator of manipulator

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Manipulator Dynamic

E. SUB COURSE DESCRIPTION` : Equation Structure of Manipulator Dynamic, Lagrangian Formula for Manipulator Dynamic, Manipulator Dynamic Formula on Cartesian Space

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Repeating brief about dynamic equation with Newton-Euler method | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about manipulator dynamic equation with using Lagrangian method | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecturer and give general description about the next lecturer | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to solve problems about problem of equation calculation of manipulator dynamic

H. TEXTBOOK :

1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

## STANDARD COURSE OUTLINE

## TKM 483 : ROBOTICS I (2 CREDITS)

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 12
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand one of the robot control application with using Microcontroller

2. SPECIFIC OBJECTIVE : Students are able to understand robot application with using Microcontroller as controller agent

B. SOFT SKILL COMPETENCY : Able to manage and process data for robot toy application

C. COURSE METHOD : Attendance, discussion and practicum

D. MAIN COURSE DESCRIPTION : Microcontroller

E. SUB COURSE DESCRIPTION` : Input/output, Interrupt, ADC, Timer/Counter

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Explaining brief about Microcontroller | Listening | LCD, Whiteboard, Microcontroller kit |
| 2 | MAIN LECTURE | 100 | Teaching and practice microcontroller kit parts and software for input/output, interrupt, ADC and timer/counter | Listening and practice | LCD, Whiteboard, Microcontroller kit |
| 3 | CONCLUSION | 10 | Discussion and conclude lecturer and give general description about the next lecturer | Listening and discussion | LCD, Whiteboard, Microcontroller kit |

G. METHODS OF ASSESSMENT : Students are able to know and manage microcontroller

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

**STANDARD COURSE OUTLINE**

**TKM 483 : ROBOTICS I (2 CREDITS)**

CLASS/LABORATORY SCHDULE : One 120-minute lectures per week
LECTURE : 13
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand one of the robot control applications with using microcontroller

2. SPECIFIC OBJECTIVE : Students are able to understand peranare able togan robot that function oriented

B. SOFT SKILL COMPETENCY : Able to make line follower robot

C. COURSE METHOD : Attendance, discussion and practicum

D. MAIN COURSE DESCRIPTION : Microcontroller

E. SUB COURSE DESCRIPTION : Pulse Width Modulation (PWM), USART

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURER | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Repeating brief about timer/counter | Listening | LCD, Whiteboard, Microcontroller kit |
| 2 | MAIN LECTURE | 100 | Teaching and practice about software of pulse width modulation and use on microcontroller | Listening and practice | LCD, Whiteboard, Microcontroller kit |
| 3 | CONCLUSION | 10 | Discussion and Conclusion | Listening and discussion | LCD, Whiteboard, Microcontroller kit |

G. METHODS OF ASSESSMENT : Students are able to make simple program for robot application

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control " 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 2nd ed
2. " Robotika : Desain, Kontrol, dan Kecerdasan Buatan ", Endra Pitowarno, Penerbit Andi,Yogyakarta, 2006.

# DIRECTION OF TEACHING PROGRAM

SUBJECT TITLE : ROBOTICS 2
INDEX NUMBER/CREDITS : TKM-484/2
BRIEF DESCRIPTION : This subject is advanced robotic 1 subject. This subject is focus on mechanics and control that used in designing manipulator as robot application for industry.
GENERAL INSTRUCTION PURPOSES : In order to students understand control concept that used in designing a robot for industry.

| NO | SPECIAL INSTRUCTION PURPOSES | MAIN SUBJECTS | SUB MAIN SUBJECTS | TIME ESTIMATION (MINUTES) | TEACHING METHODS | SOFT SKILL CAPABILITY | REFERENCE SOURCES |
|---|---|---|---|---|---|---|---|
| 1 | Understand description of manipulator track as polynomial equations | Track | Description of track, joint space scheme | 120 | Attendance, discusion | Can design manipulator track | 1 |
| 2 | Understand track scheme on Cartesian space | Track | Cartesian space scheme, geometry problem on track | 120 | Attendance, discusion, practices and homework | Can analyze track problem on manipulator geometry | 1 |
| 3 | Understand mechanic aspects in designing manipulator | Manipulator Mechanic Design | Basic of designing robot, kinematic configurations, kuantitative measurement from workspace attribute, closed chain structure | 120 | Attendance, discusion | Can determine number of joint, its kind and how to build | 1 |
| 4 | Understand and can choose actuator in designing manipulator manipulator | Manipulator Mechanic Design | Aktuator scheme, stiffness and deflection, censor position | 120 | Attendance, discusion, practices and homework | Can distinct advantage and disadvantage based on actuator election | 1 |
| 5 | Understand linear control method for | Manipulator Linear Control | Application of linear control. | 120 | Attendance, discusion | Can simplify linear control | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | second orde system | | Second order linear system, second order system control, control separation | | | cases on manipulator | |
| 6 | Understand application of manipulator linear control based on track | Manipulator Linear Control | Control follow track, refusal of disturbance, continue time control versus discrete, modelling and one joint control | 120 | Attendance, discusion, practices and homework | Can make a control model on join manipulator | 1 |
| 7 | Understand one or two methods for non-linear control in controlling manipulator | Manipulator Non-Linear Control | Time variation system and non-linear, input and output , multy control system control problem on manipulator, industrial robot control system new | 120 | Attendance, discusion | Can distinct linear application and control non-linear | 1 |
| 8 | Can analyze stabilization of manipulator for non-linear control | Manipulator Non-Linear Control | Analyze Iyapunov stability, control system based on cartesian, adaptive control | 120 | Attendance, discusion, practices and homework | Can analyze with using MATLAB | 1 |
| 9 | Can understand about natural and artificial constraint as force circuit that is given by end-ejector when is applying. | Manipulator Force Control | Application of industrial robot for working assembly, framework control for working is constrained, position control | 120 | Attendance, discusion | Can analyze kind of constrain on manipulator | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | cluster and force | | | | |
| 10 | Know and understand application of force control on industrial robot. | Manipulator Force Control | Force control from mass and apring, position control scheme and force, control scheme of industrial robot new | 120 | Attendance, discusion, practices and homework | Can make force control scheme based on joints is applied | 1 |
| 11 | Know and understand working principle of kind of censor that is applied on manipulator | Censor | Censor range, censor proximity, touch censor | 120 | Attendance, discusion | Can distinct censor based on its applications | 2 |
| 12 | Know and understand working principle of kind of censor that is applied on manipulator | Censor | Force censor, torsion censor | 120 | Attendance, discusion | Can distinct censor based on its applications | 2 |

References : 1. "Introduction To Robotics : Mechanics And Control ", 2nd ed, John J. Craig, Addison-Wesley Publishing Company, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

**STANDARD COURSE OUTLINE**

**TKM 484 : ROBOTICS II (2 CREDITS)**

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 1
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to know and understand how robot track is planned

2. SPECIFIC OBJECTIVE : Students are able to understand about description of manipulator link an polynomial equations

B. SOFT SKILL COMPETENCY : Able to design manipulator track

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Tracking

E. SUB COURSE DESCRIPTION` : Track Description, joint space scheme

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching about kinds of robot track | Listening | LCD, Whiteboard, robot toy |
| 2 | MAIN LECTURE | 90 | Teaching about how robot track is planned and its relationship with joint on robot that as polynomial equations that determines position, speed and acceleration of robot track | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecture and give general description about the next lecture | Listening | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to calculate position, speed and acceleration of robot track that is planned

H. TEXTBOOK :

1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

**STANDARD COURSE OUTLINE**

**TKM 484 : ROBOTICS II (2 CREDITS)**

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 2
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to know and understand how robot track is planned

2. SPECIFIC OBJECTIVE : Students are able to know and understand track scheme on Cartesian space

B. SOFT SKILL COMPETENCY : Able to analyze problems of track to manipulator geometry

C. COURSE METHOD : Attendance, discussion , practice and homework

D. MAIN COURSE DESCRIPTION : Tracking

E. SUB COURSE DESCRIPTION` : cartesian space scheme, problem of geometry to track

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Repeating brief about polynomial equation as planned track | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about Cartesian space scheme and its relationship with problems that occur caused by track planning | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecture and give general description about the next lecture | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to imagine problems that probably occur related to planned track

H. TEXTBOOK :

1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

**STANDARD COURSE OUTLINE**

**TKM 484 : ROBOTICS II (2 CREDITS)**

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 3
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand elements in designing manipulator

2. SPECIFIC OBJECTIVE : Students are able to understand mechanic aspect in designing manipulator

B. SOFT SKILL COMPETENCY : Are able to determine joint numbers, its kinds, manipulator space and workspace

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Manipulator Mechanic Design

E. SUB COURSE DESCRIPTION` : Robot Planning Basic, kinematics configurations, measurement from quantitative attributes of workspace, closed chain structure

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching about mechanic of product | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about basic design of manipulator include something that have to be considered. Continued to teach kinematics configurations of manipulator that is designed | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecture and give general description about the next lecture | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to draw kinematics configurations from manipulator that is designed

H. TEXTBOOK :

1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

**STANDARD COURSE OUTLINE**

**TKM 484 : ROBOTICS II (2 CREDITS)**

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 4
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand elements in designing manipulator
2. SPECIFIC OBJECTIVE : Students are able to understand and choose actuator in designing manipulator

B. SOFT SKILL COMPETENCY : Are able to analyze in distinct advantage and disadvantage from election of actuator

C. COURSE METHOD : Attendance, discussion , practice and homework

D. MAIN COURSE DESCRIPTION : Manipulator Mechanic Design

E. SUB COURSE DESCRIPTION` : Actuator scheme, stiffness and deflection, and censor position

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching briefly about kinematics configurations and its relationship with workspace | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about actuator position, choosed actuator, transmition system and censor position that placed on manipulator | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecture and give general description about the next lecture | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to determine kinds of actuator and censor that will be used in designing manipulator

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

## STANDARD COURSE OUTLINE

## TKM 484 : ROBOTICS II (2 CREDITS)

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 5
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand control method on manipulator in reaching end-efector track that is planned

2. SPECIFIC OBJECTIVE : Able to understand linear control method for second order system

B. SOFT SKILL COMPETENCY : Able to simply linear control cases on manipulator

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Manipulator Linear Control

E. SUB COURSE DESCRIPTION` : Application of Linear Control, second order linear system, second order Control System, dissociation of control

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching briefly about linear control system | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about linear control on manipulator that can be simplified to second order system | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecture and give general description about the next lecture | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to show sample of system that use linear control

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

## STANDARD COURSE OUTLINE

## TKM 484 : ROBOTICS II (2 CREDITS)

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 6
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand control method on manipulator in reaching end-efector track that is planned

2. SPECIFIC OBJECTIVE : Able to understand application of manipulator linear control based on track

B. SOFT SKILL COMPETENCY : Able to model control on manipulator joint

C. COURSE METHOD : Attendance, discussion , practice and homework

D. MAIN COURSE DESCRIPTION : Manipulator Linear Control

E. SUB COURSE DESCRIPTION` : Track followed control, refusing disturbance, continue time control vs. discrete, model and control of one joint

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Repeating briefly about second order linear control | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about track followed control that its input as position and modeled on one joint | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecture and give general description about the next lecture | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to model as mechanic from torsion motor that is used as actuator on joint

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

## STANDARD COURSE OUTLINE

## TKM 484 : ROBOTICS II (2 CREDITS)

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 7
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand non-linear control that often occur on manipulator

2. SPECIFIC OBJECTIVE : Able to understand first or second method fro non-linear control in controlling manipulator

B. SOFT SKILL COMPETENCY : Able to distinct applications of linear and non-linear control

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Manipulator Non-Linear Control

E. SUB COURSE DESCRIPTION` : TIME variation and non-linear system, multi input multi output control system, problem of control on manipulator, new of industrial robot control system

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | MEDIA DAN ALAT PEMBELAJARAN |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching briefly about non-linear control r | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about linear control that occur on manipulator from used method, the problems, and new kinds that often applied in industry | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecture and give general description about the next lecture | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to understand n on-linear control for industrial robot

H. TEXTBOOK :

1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

**STANDARD COURSE OUTLINE**

**TKM 484 : ROBOTICS II (2 CREDITS)**

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 8
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand non-linear control that often occur on manipulator

2. SPECIFIC OBJECTIVE : Able to analyze stability of manipulator fro non-linear control

B. SOFT SKILL COMPETENCY : Able to analyze with using MATLAB

C. COURSE METHOD : Attendance, discussion , practice and homework

D. MAIN COURSE DESCRIPTION : Manipulator Non-Linear Control

E. SUB COURSE DESCRIPTION` : Iyapunov Stability Analysis, control system based on Cartesian, adaptive control

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching briefly about stability analysis on control | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about Iyapunov Stability Analysis to know what control system that is planned is stable or not | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecture and give general description about the next lecture | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to solve analysis with using MATLAB software

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

## STANDARD COURSE OUTLINE

## TKM 484 : ROBOTICS II (2 CREDITS)

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 9
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand force control concept on manipulator

2. SPECIFIC OBJECTIVE : Students are able to understand natural and artificial constraint as force constrictor that is given by end-efector when it is using

B. SOFT SKILL COMPETENCY : Able to analyze kinds of constrain on manipulator

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Manipulator Force Control

E. SUB COURSE DESCRIPTION` : Application of industrial robot for assembly work, control frame work for work is constrained, problem of position and force control cluster

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching briefly about why use force control on manipulator when it is using | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about natural constraint, artificial constraint and its relationship with end-efector position control from manipulator | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecture and give general description about the next lecture | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to analyze kind of constraint and determine its value if it is given a manipulator design based on its working process

H. TEXTBOOK :

1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

## STANDARD COURSE OUTLINE

## TKM 484 : ROBOTICS II (2 CREDITS)

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 10
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand force control concept on manipulator

2. SPECIFIC OBJECTIVE : Students are able to know and understand application of force control on industrial robot

B. SOFT SKILL COMPETENCY : Able to make force control scheme from used joints

C. COURSE METHOD : Attendance, discussion , practice and homework

D. MAIN COURSE DESCRIPTION : Manipulator Force Control

E. SUB COURSE DESCRIPTION` : Force control from mass and spring, position and force control scheme, new of industrial robot control scheme

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching briefly about force control on manipulator | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about force control equation on imagery of the thing that is joined with spring as a system and continued control scheme on industrial robot that apply position and force control | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecture and give general description about the next lecture | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to make scheme of robot control for force and position control

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

## STANDARD COURSE OUTLINE

## TKM 484 : ROBOTICS II (2 CREDITS)

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 11
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand basic concept about censor as assistive appliance goes to automatization

2. SPECIFIC OBJECTIVE : Students are able to know and understand working principle of censor kinds that applied on manipulator

B. SOFT SKILL COMPETENCY : Able to distinct censor based on its applications

C. COURSE METHOD : Attendance and discussion

D. MAIN COURSE DESCRIPTION : Censor

E. SUB COURSE DESCRIPTION` : Censor Range, proximity censor, touch censor

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 15 | Teaching briefly about censor | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 90 | Teaching about range of censor, proximity censor and touch censor that often applied in designing manipulator r | Listening | LCD, Whiteboard |
| 3 | CONCLUSION | 15 | Discussion and conclude lecture and give general description about the next lecture | Listening and discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to distinct advantage and disadvantage of some censor

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

**STANDARD COURSE OUTLINE**

**TKM 484 : ROBOTICS II (2 CREDITS)**

CLASS/LABORATORY SCHEDULE : One 120-minute lectures per week
LECTURE : 12
A. COURSE OBJECTIVES :
1. GENERAL OBJECTIVE : Students are able to understand basic concept about censor as assistive appliance goes to automatization

2. SPECIFIC OBJECTIVE : Students are able to know and understand working principle of censor kinds that applied on manipulator

B. SOFT SKILL COMPETENCY : Able to distinct censor based on its applications

C. COURSE METHOD : Attendance, practicum and discussion

D. MAIN COURSE DESCRIPTION : Censor

E. SUB COURSE DESCRIPTION` : Force Censor, Torsion Censor

F. COURSE ACTIVITY :

| NO | PROGRESS | TIME (MINUTE) | LECTURE ACTIVITY | STUDENT'S ACTIVITY | EQUIPMENT SUPPORTING |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Teaching briefly about censor on joint or link | Listening | LCD, Whiteboard |
| 2 | MAIN LECTURE | 100 | Teaching kinds working principle. Force censor and torsion censor that often applied for manipulator | Listening and Practicing | LCD, Whiteboard |
| 3 | CONCLUSION | 10 | Discussion and summary lecture | Listening and Discussion | LCD, Whiteboard |

G. METHODS OF ASSESSMENT : Students are able to distinct advantage and disadvantage of some censor

H. TEXTBOOK :
1. "Introduction To Robotics : Mechanics And Control ", John J. Craig, Addison-Wesley Publishing Company, 2nd ed, 1989.
2. " Robotics : Control, Sensing, Vision and Intellegence ", K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill Book Company, 1987.

| | |
|---|---|
| SUBJECT TITLE | **Rotor Dynamic** |
| SUBJECT CODE / CREDITS | TKM485 / 2 |
| BRIEF DESKRIPTION | This subject is optional subject in design and manufacture |
| GENERAL COURSE OBJECTIVES | 1. Students will learn mathematical modelling<br>2. Students can analyze dynamical system of rotor<br>3. Students will able to apply their knowledge to design rotor for various applications<br>4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation. |

| No | SPECIFIC OBJECTIVE | MAIN COURSE DESCRIPTION | SUB COURSE DESCRIPTION | TIME ESTIMATE (MINUTE) | COURSE METHOD | SOFTSKILL COMPETENCY | REFERENCE |
|---|---|---|---|---|---|---|---|
| 1 | Students will have knowledge of rotor system and rotor characteristic including structure and industrial application | Introduction | Types of rotor, history of usage, aplication | 90 | Teoretical Lectures | Students will have self motivation for study | 1 & 2 |
| 2 | Students can understand and learn characteristic of disc and shaft rotor element, Students will learn analitical equation | Characteristic of Rotor Elements | Disk, bearing, shaft | 90 | Teoretical Lectures | Students will able to explain dynamical system of rotor in professional communication | 1 & 2 |
| 3 | Students will understand and learn characteristic of rotor bearing element and seals, Students will understand and learn mass unbalance, Students will learn analitical equation | Rigid Rotor Model, massless shaft | Mathematical modelling, differential equation | 90 | Teoretical Lectures | Students will able to explain dynamical system of rotor in professional communication | 1 & 2 |
| 4 | Student will learn basic model of rotor and analytical equation | Rigid Rotor Model | Solution of differential equation | 90 | Teoretical Lectures | Student have analytical competency | 1 & 2 |
| 5 | Students can determine stability of damped rotor | Campbell Diagram & Matlab | Natural frequency dan synchronous vibration | 90 | Teoretical Lectures | Student have analytical competency | 1 & 2 |
| 6 | Students will learn the effect of mass unbalance | Mass Unbalance | Static unbalance | 90 | Teoretical Lectures | Student have analytical competency | 1 & 2 |
| 7 | Student can determine vibration value caused by mass unbalance | Mass Unbalance | Dynamic unbalance | 90 | Teoretical Lectures | Student have analytical competency | 1 & 2 |
| 8 | | Midtes | | 90 | Tes | | |
| 9 | Students will able to use measuring equipment and how to measure of rotor dynamic vibration | Rotor Vibration Measurement | Transducer, wiring, signal conditioning dan electronic instrument | 90 | Teoretical Lectures | Student are able to use rotor vibration measurement equipment | 5 |
| 10 | Students will learn finite element methode mathematical modelling of rotor elements | Finite Element Method | Mathematical modelling of simple rotor | 90 | Teoretical Lectures | Student have analytical competency | 1 & 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11 | Student will learn single rotor equation system and coaxial rotor with finite element method basic | Finite Element Method | Mathematical modelling of complex rotor | 90 | Teoretical Lectures | Student have analytical competency | 1 & 2 |
| 12 | Student will learn single rotor equation system and coaxial rotor with finite element method basic | Passive balancing | Mathematical modelling for static and dinamic balancing | 90 | Teoretical Lectures | Student are able to design damped rotor | 5 |
| 13 | Student can understand the benefit of autobalancing and how to design of autobalance simulation using software | Autobalancing | Aplication of autobalancing, autobalancing for disk and fix rotor. Efect of rotor flexibility | 90 | Teoretical Lectures | Student are able to design rotor | 5 |
| 14 | Students will able to understand how to design computer simulation of active magnetic bearing (AMB) | Active Magnetic Bearing (AMB) | Aplication of AMB. AMB for fix rotor | 90 | Teoretical Lectures | Student are able to design rotor | 4 |
| 15 | Students will able to understand how to design computer simulation of active magnetic bearing (AMB) | Active Magnetic Bearing (AMB) | Rotor flexibility effect of active magnetic bearing stabillity | 90 | Teoretical Lectures | Student are able to design rotor | 4 |
| 16 | | Final Exam | | 90 | Tes | | |

Reference


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes dan journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 1

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
2. SPECIFIC OBJECTIVE — Students will have knowledge of rotor system and rotor characteristic including structure and industrial application

B. SOFTSKILL COMPETENCY : — Students will have self motivation for study

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Introduction

E. SUB COURSE DESCRIPTION — Types of rotor, history of usage, aplication

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 2

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications

2. SPECIFIC OBJECTIVES
   Students can understand and learn characteristic of disc and shaft rotor element
   Students will learn analitical equation

B. SOFTSKILL COMPETENCY : Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD : Teoretical Lectures

D. MAIN COURSE DESCRIPTION : Characteristic Rotor Elements

E. SUB COURSE DESCRIPTION : Disk, bearing, shaft

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :
- 8 homework 20%
- 4 Quiz 10 %
- 1 Project Report 25
- 1 Midtes 20 %
- 1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 3

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications

2. SPECIFIC OBJECTIVES
   Students will understand and learn characteristic of rotor bearing element and seals
   Students will understand and learn mass unbalance
   Students will learn analitical equation

B. SOFTSKILL COMPETENCY : Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD : Teoretical Lectures

D. MAIN COURSE DESCRIPTION : Rigid Rotor Model, massless shaft

E. SUB COURSE DESCRIPTION : Mathematical modelling, differential equation

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :
- 8 homework 20%
- 4 Quiz 10 %
- 1 Project Report 25
- 1 Midtes 20 %
- 1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 4

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
2. SPECIFIC OBJECTIVE — Student will learn basic modell of rotor and analytical equation

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Rigid Rotor Model

E. SUB COURSE DESCRIPTION — Solution of differential equation

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 5

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVES — Students can determine stability of damped rotor

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Campbell Diagram & Matlab

E. SUB COURSE DESCRIPTION — Natural frequency dan synchronous vibration

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 6

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Students will learn the effect of mass unbalance

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Mass Unbalance

E. SUB COURSE DESCRIPTION — Static unbalance

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 7

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Student can determine vibration value caused by mass unbalance

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Mass Unbalance

E. SUB COURSE DESCRIPTION — Dinamic unbalance

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK

1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 8

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Students will able to use measuring equipment and how to measure of rotor dynamic vibration

B. SOFTSKILL COMPETENCY : Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Rotor Vibration Measurement

E. SUB COURSE DESCRIPTION — Transducer, wiring, signal conditioning and electronic instrument

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 9

A. COURSE OBJECTIVES
1. GENERAL OBJECTIVES
1. Students will learn mathematical modelling
2. Students can analyze dynamical system of rotor
3. Students will able to apply their knowledge to design rotor for various applications
4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.

2. SPECIFIC OBJECTIVE — Students will learn finite element methode mathematical modelling of rotor elements

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Finite Element Method

E. SUB COURSE DESCRIPTION — Mathematical modelling of simple rotor

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :
8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 10

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Student will learn single rotor equation system and coaxial rotor with finite element method basic

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Finite Element Method

E. SUB COURSE DESCRIPTION — Mathematical modelling of complex rotor

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK

1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.

2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 11

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.

2. SPECIFIC OBJECTIVE — Student will learn single rotor equation system and coaxial rotor with finite element method basic□

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Passive balancing

E. SUB COURSE DESCRIPTION — Mathematical modelling for static and dinamic balancing

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 12

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.

2. SPECIFIC OBJECTIVE — Student can understand the benefit of autobalancing and how to design of autobalance simulation using software

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Autobalancing

E. SUB COURSE DESCRIPTION — Aplication of autobalancing, autobalancing for disk and fix rotor. Efect of rotor flexibility

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK

1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.

2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 13

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Students will able to understand how to design computer simulation of active magnetic bearing (AMB)

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Active Magnetic Bearing (AMB)

E. SUB COURSE DESCRIPTION — Aplication of AMB. AMB for fix rotor

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK

1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.

2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 14

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Students will able to understand how to design computer simulation of active magnetic bearing (AMB)

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Active Magnetic Bearing (AMB)

E. SUB COURSE DESCRIPTION — Rotor flexibility effect of active magnetic bearing stabillity

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quizzes 10 %
1 Project Report 25
1 Mid Examination 20 %
1 Final Examination 25 %

H. TEXTBOOK

1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995

3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 8

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Students will able to use measuring equipment and how to measure of rotor dynamic vibration

B. SOFTSKILL COMPETENCY : Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Rotor Vibration Measurement

E. SUB COURSE DESCRIPTION — Transducer, wiring, signal conditioning and electronic instrument

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 9

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Students will learn finite element methode mathematical modelling of rotor elements

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Finite Element Method

E. SUB COURSE DESCRIPTION — Mathematical modelling of simple rotor

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 10

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Student will learn single rotor equation system and coaxial rotor with finite element method basic

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Finite Element Method

E. SUB COURSE DESCRIPTION — Mathematical modelling of complex rotor

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK

1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.

2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 11

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Student will learn single rotor equation system and coaxial rotor with finite element method basic□

B. SOFTSKILL COMPETENCY : Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Passive balancing

E. SUB COURSE DESCRIPTION — Mathematical modelling for static and dinamic balancing

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK


1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 12

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.

2. SPECIFIC OBJECTIVE — Student can understand the benefit of autobalancing and how to design of autobalance simulation using software

B. SOFTSKILL COMPETENCY : — Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Autobalancing

E. SUB COURSE DESCRIPTION — Aplication of autobalancing, autobalancing for disk and fix rotor. Efect of rotor flexibility

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :

8 homework 20%
4 Quiz 10 %
1 Project Report 25
1 Midtes 20 %
1 Ujian akhir 25 %

H. TEXTBOOK

1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.

2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 13

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Students will able to understand how to design computer simulation of active magnetic bearing (AMB)

B. SOFTSKILL COMPETENCY : Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Active Magnetic Bearing (AMB)

E. SUB COURSE DESCRIPTION — Aplication of AMB. AMB for fix rotor

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :
- 8 homework 20%
- 4 Quiz 10 %
- 1 Project Report 25
- 1 Midtes 20 %
- 1 Ujian akhir 25 %

H. TEXTBOOK

1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.

2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995
3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

**TKM 485 : ROTOR DYNAMIC (2 CREDITS)**

CLASS/LABORATORY SCHEDULE — One 90-minute lectures per week
LECTURE — 14

A. COURSE OBJECTIVES

1. GENERAL OBJECTIVES
   1. Students will learn mathematical modelling
   2. Students can analyze dynamical system of rotor
   3. Students will able to apply their knowledge to design rotor for various applications
   4. Students will able to use computer software for analysis, simulation and rotor dynamic presentation.
2. SPECIFIC OBJECTIVE — Students will able to understand how to design computer simulation of active magnetic bearing (AMB)

B. SOFTSKILL COMPETENCY : Students will able to explain dynamical system of rotor in professional communication

C. COURSE METHOD — Teoretical Lectures

D. MAIN COURSE DESCRIPTION — Active Magnetic Bearing (AMB)

E. SUB COURSE DESCRIPTION — Rotor flexibility effect of active magnetic bearing stabillity

F. COURSE ACTIVITY

| NO | OVERVIEW | TIME ESTIMATE | CLASS ACTIVITY | STUDENT ACTIVITY | COURSE EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 2 | MAIN LECTURE | 70 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |
| 3 | CONCLUSION | 10 | Presentation+discussion | Listening, reading, writing and asking | LCD Projector+Laptop |

G. METHODS OF ASSESSMENT :
- 8 homework 20%
- 4 Quizzes 10 %
- 1 Project Report 25
- 1 Mid Examination 20 %
- 1 Final Examination 25 %

H. TEXTBOOK

1. Lalanne, M., Ferraris, G., Rotordynamics Prediction in Engineering, 2nd ed.John Wiley and Sons Ltd., West Sussex, 1997.
2. Genta, Giancarlo, Vibration of Structures and Machines, 2nd ed., Springer Verlag, New York, 1995

3. Toshio Yamamoto & Yukio Ishida, "Linear & Nonlinear Rotordynamics", John Wiley & Sons, New York 2001
4. A. Chiba et. Al, "Magnetic Bearing & Bearingless Drive," Elsevier, Burlington, Massachusetts, 2005
5. Class notes and journal

# GARIS-GARIS BESAR PROGRAM PEMBELAJARAN

JUDUL MATA KULIAH : Struktur Ringan
NOMOR KODE/SKS : TKM 486 / 2 SKS
DESKRIPSI SINGKAT : Matakuliah ini dimaksudkan untuk memberi bekal pemahaman kepada peserta kuliah mengenai struktur ringan, metoda analisis dan penerapanya pada perancangan pesawat udara dan kendaraan. Peserta diharapkan telah mengikuti matakuliah Statika, Mekanika Kekuatan Bahan dan Material Teknik
TUJUAN INSTRUKSIONAL UMUM : Setelah mengikuti kuliah ini diharapkan mahasiswa
- Memahami pengertian dan aplikasi struktur ringan
- Mampu menganalisis dan merancang struktur ringan sesuai dengan keperluannya

| No | TUJUAN INSTRUKSIONAL KHUSUS | POKOK BAHASAN | SUB POKOK BAHASAN | ESTIMASI WAKTU (MENIT) | METODE PEMBELAJARAN | KEMAMPUAN SOFT SKILL | SUMBER KEPUSTAKAAN |
|---|---|---|---|---|---|---|---|
| 1 | - Understand various analysis method in engineering field<br>- Understand basic principle of numerical method | Introduction to light structure | - The definition of light structure<br>- Monoque and semi-monoque structure<br>- Light structure application in industry | 100 | - Presentation<br>- Discussion<br>- Self-supporting activity | - Ability for giving opinion<br>- Ability for understanding others opinion<br>- Ability for self-supporting activity | Pustaka 2 |
| 2 | - Review of basic principle on mechanical strength of material analysis | Review of mechnical strength of material | - The definition of light structure<br>- Monoque and semi-monoque structure<br>- Light structure application in industry | 100 | - Presentation<br>- Discussion<br>- Self-supporting activity | - Ability for giving opinion<br>- Ability for understanding others opinion<br>- Ability for self-supporting activity | Pustaka 1 & 2 |
| 3 | - Review of basic principle of elasticity | Introduction Elastiicity theory | - Balance equation<br>- Saint-Venan T principle Compatibility<br>- Airy and Prandt stress function | 100 | - Presentation<br>- Discussion<br>- Self-supporting activity | - Ability for giving opinion<br>- Ability for understanding others opinion<br>- Ability for self-supporting activity | Pustaka 1 & 3 |
| 4 | - Understand and able to determine torque, twist angle, and stress distribution on circular bar | Torque on cylindrical bar | - Torque on circular bar<br>- Power transmission on cylindric axes | 100 | - Presentation<br>- Discussion<br>- Self-supporting activity | - Ability for giving opinion<br>- Ability for understanding others opinion<br>- Ability for self-supporting activity | Pustaka 2 |
| 5 | - Understand and able to determine torque, twist angle, and stress distribution on circular bar | Torque on non-cylindrical bar | - Torque on non-circular bar<br>- Torque on open thin wall bar | 100 | - Presentation<br>- Discussion<br>- Self-supporting activity | - Ability for giving opinion<br>- Ability for understanding others opinion<br>- Ability for self-supporting activity | Pustaka 2 |
| 6 | - Understand and able to determine torque, twist angle, and stress distribution on single | Torque on thin-wall single cell | - Twist tube<br>- Torque on closed thin wall single celll | 100 | - Presentation<br>- Discussion<br>- Self-supporting | - Ability for giving opinion<br>- Ability for understanding others opinion | Pustaka 1 & 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | cell structure | | | | activity | - Ability for self-supporting activity | |
| 7 | - Understand and able to determine torque, twist angle, and stress distribution on plural cell structure | Torque on open thin-wall plural cell | - Torque moment on internal slip flow system<br>- Torque slip stress distribution<br>- Twist angle | 100 | - Presentation<br>- Discussion<br>- Self-supporting activity | - Ability for giving opinion<br>- Ability for understanding others opinion<br>- Ability for self-supporting activity | Pustaka 1 & 2 |
| 8 | - Understand and able to determine torque, twist angle, and stress distribution on plural cell bar using suksesive correction method | Suksesiv correction method | - Suksesiv correction method differentiation<br>- Torque slip flow on plural cell bar | 100 | - Presentation<br>- Discussion<br>- Self-supporting activity | - Ability for giving opinion<br>- Ability for understanding others opinion<br>- Ability for self-supporting activity | Pustaka 1 & 2 |
| 9 | - Able to determine the center of slip and bending slip stress on symmetrical bar | Bending slip stress and center of slip | - Center of slip definition<br>- Bending slip stress on symmetric bar | 100 | - Presentation<br>- Discussion<br>- Self-supporting activity | - Ability for giving opinion<br>- Ability for understanding others opinion<br>- Ability for self-supporting activity | Pustaka 1 & 2 |
| 10 | - Able to determine the center of flow and slip on single or plural cell | Slip flow on closed thin-wall body | - Slip flow and center of slip on single cell<br>- Slip flow and center of slip on plural cell | 100 | - Presentation<br>- Discussion<br>- Self-supporting activity | - Ability for giving opinion<br>- Ability for understanding others opinion<br>- Ability for self-supporting activity | Pustaka 1 & 2 |
| 11 | - Understand membrane stress on pressure vessel | Slip flow on closed thin-wall body | - Membrane balance equation<br>- Simple pressure vessel<br>- Movement, boundary layer, and local bending on thin-wall shell | 100 | - Presentation<br>- Discussion<br>- Self-supporting activity | - Ability for giving opinion<br>- Ability for understanding others opinion<br>- Ability for self-supporting activity | Pustaka 1 & 2 |
| 12 | - Understand deflection on plate | Plate deflection | - Memplate deflection equation<br>- Plate deflection cases | 100 | - Presentation<br>- Discussion<br>- Self-supporting activity | - Ability for giving opinion<br>- Ability for understanding others opinion<br>- Ability for self-supporting activity | Pustaka 1 & 2 |

**Pustaka :**


1. Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2. Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.
3. Timoshenko, Goodier, *Theory of Elasticity*, M Graw-Hill Book Companies, Inc. 1951

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 1st

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Understand various analysis method in engineering field
- Understand basic principle of numerical method

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Introduction to light structure

E. Sub Course description:
- the definition of light structure
- Monoque and semi-monoque structure
- light structure application in industry

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Ecplaining about the importance of project | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- the definition of light structure<br>- Monoque and semi-monoque structure<br>- light structure application in industry | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.
3.Timoshenko, Goodier, *Theory of Elasticity*, M Graw-Hill Book Companies, Inc. 1951

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 2nd

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Review of basic principle on mechanical strength of material analysis

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Review of mechnical strength of material

E. Sub Course description:
- the definition of light structure
- Monoque and semi-monoque structure
- light structure application in industry

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Ecplaining about basic analysis of light structure | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- the relationship between stress-strain<br>- normal stress and slip stress<br>- bar deflection and buckling stability<br>- energy method | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.
3.Timoshenko, Goodier, *Theory of Elasticity*, M Graw-Hill Book Companies, Inc. 1951

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 3rd

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Review of basic principle of elasticity

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Review of mechanical strength of material

E. Sub Course description:
- Balance equation
- Saint-Venan T principle
- Airy and Prandt stress function

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Global explanation about elasticity theory | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- Balance equation<br>- Saint-Venan T principle<br>- Airy and Prandt stress function | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.
3.Timoshenko, Goodier, *Theory of Elasticity*, M Graw-Hill Book Companies, Inc. 1951

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 4th

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Understand and able to determine torque, twist angle, and stress distribution on circular bar

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Torque on cylindrical bar

E. Sub Course description:
- Torque on circular bar
- Power transmission on cylindric axes

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Global explanation about Torque on cylindrical bar | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- Torque on circular bar<br>- Power transmission on cylindric axes | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.
3.Timoshenko, Goodier, *Theory of Elasticity*, M Graw-Hill Book Companies, Inc. 1951

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 5th

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Understand and able to determine torque, twist angle, and stress distribution on circular bar

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Torque on non-cylindrical bar

E. Sub Course description:
- Torque on non-circular bar
- Torque on open thin wall bar

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Global explanation about Torque on non-cylindrical bar | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- Torque on non-circular bar<br>- Torque on open thin wall bar | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.
3.Timoshenko, Goodier, *Theory of Elasticity*, M Graw-Hill Book Companies, Inc. 1951

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 6th

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Understand and able to determine torque, twist angle, and stress distribution on single cell structure

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Torque on thin-wall single cell

E. Sub Course description:
- Twist tube
- Torque on closed thin wall single celll

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Global explanation about Torque on thin-wall single cell | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- Twist tube<br>- Torque on closed thin wall single celll | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.
3.Timoshenko, Goodier, *Theory of Elasticity*, M Graw-Hill Book Companies, Inc. 1951

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 7th

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Understand and able to determine torque, twist angle, and stress distribution on plural cell structure

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Torque on open thin-wall plural cell

E. Sub Course description:
- Torque moment on internal slip flow system
- torque slip stress distribution
- Twist angle

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Global explanation about Torque on open thin-wall plural cell | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- Torque moment on internal slip flow system<br>- torque slip stress distribution<br>- Twist angle | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 8th

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Understand and able to determine torque, twist angle, and stress distribution on plural cell bar using suksesive correction method

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Suksesiv correction method

E. Sub Course description:
- Suksesiv correction method differentiation
- Torque slip flow on plural cell bar

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Global explanation about Suksesiv correction method | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- Suksesiv correction method differentiation<br>-Torque slip flow on plural cell bar | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 9th

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Able to determine the center of slip and bending slip stress on symmetrical bar

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Bending slip stress and center of slip

E. Sub Course description:
- center of slip definition
- Bending slip stress on symmetric bar

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Global explanation about Bending slip stress and center of slip | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- center of slip definition<br>- Bending slip stress on symmetric bar | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 10th

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Able to determine the center of flow and slip on single or plural cell

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Slip flow on closed thin-wall body

E. Sub Course description:
- Slip flow and center of slip on single cell
- Slip flow and center of slip on plural cell

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Global explanation about Slip flow on closed thin-wall body | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- Slip flow and center of slip on single cell<br>- Slip flow and center of slip on plural cell | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 11th

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Understand membrane stress on pressure vessel

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Slip flow on closed thin-wall body

E. Sub Course description:
- Membrane balance equation
- Simple pressure vessel
- Movement, boundary layer, and local bending on thin-wall shell

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Global explanation about stress of membrane | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- Membrane balance equation<br>- Simple pressure vessel<br>- Movement, boundary layer, and local bending on thin wall shell | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.

# STANDARD COURSE OUTLINE

Subject : LIGHT STRUCTURE
Subject Code : TKM 486
Subject Credit : 2
Class schedule : 1 x 100 minutes
Lecture : 12th

A. Course Objective
1. General Objective : - Understand the definition and application of light structure
- Able to design and to analyze the most suitable light structure

2. Specific Objective : - Understand deflection on plate

B. Desirable student competencies:
- Ability for giving opinion
- Ability for understanding others opinion
- Ability for self-supporting activity

C. Course Method:
- Presentation
- Discussion
- Self-supporting activity

D. Main course description:
Plate deflection

E. Sub Course description:
- Memplate deflection equation
- Plate deflection cases

F. Course Activity:

| No | PROGRESSION | TIME ESTIMATION | LECTURER ACTIVITY | STUDENT ACTIVITY | RESOURCES COMMONLY AVAILABLE |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 20 | Global explanation about Plate deflection | Listening | LCD<br>White board<br>Computer |
| 2 | PRESENTATION | 70 | Detail explanation about:<br>- Memplate deflection equation<br>- Plate deflection cases | Paying attention<br>Q & A | LCD<br>White board<br>Color marker |
| 3 | CLOSING | 10 | -Giving course conclusion<br>- Feedback question | Q &A | LCD<br>White board<br>Color marker |

G. Method of assessment
Self tasking problem

H. Text Book

1.Budynas, R.G., *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill Companies, Inc., 1999.
2.Bruhn, *Analysis and Design of Flight Vehicle Structures*, S.R. Jacobs & Associates, Inc.

# BASIC RULE OF STUDY PROGRAM

MAJOR SUBJECT : **INDUSTRION TRIBOLOGY**
CODE NUMBER/CREDIT : TKM-487/2
DESCRIPTION : This course studies about basic knowledge's and the industrial application at world of science and tribology technology. The course will be started with knowledge giving about definition, history and tribology event. Student will be supplied with knowledge about friction, Lubrication and Lubricant characters. Lubrication types and how it use will be explained detail. Besides, kinds of minimization pads of friction to will be explained in detail. Then student introduced at the abrasion concept and relationship with friction and also Lubrication and various example of its(the usages at industrial world. Study case about trouble-shooting at tribology will be passed to this course the end of sessions. So student can exercises directly at o science and tribology technology application

GENERAL INSTRUCTIONAL : Having completed this course the student can apply. elaborates and finalizes tribology problems at industrial world

| NO | GENERAL INSTRUCTIONAL SPECIAL | MAJOR SUBJECT PRINCIPAL | SUB MAJOR SUBJECT PRINCIPAL | TIME ESTIMATE (MENIT) | TEACHING METHOD | SOFT SKILL ABILITY | REFERENCE SOURCE |
|---|---|---|---|---|---|---|---|
| 1 | Student comprehends science tribology to start from meaning, development history and role to progress of science and technology till now | INTRODUCTION | Meaning of tribology, tribology event, history of tribology, tribology of problems solver and economics aspect generated, mikro-nano tribology and the application at industrial world. | 100 | Presentation using proyector, OHP, and white board. | Student comprehends the importance of history | Book 2 chapter 1<br>Book 3 chapter 1 |
| 2 | Understands surface character of a solid object and it's effect to contact mechanics, friction, Lubrication and other result like fretting, scuffing etc. | Friction and Lubrication at boundary layer a solid goods | Surface physical properties of the solid object and contact phenomenon, friction, Lubrication of boundary layer, Lubrication of solid and fretting | 100 | Presentation using proyector, OHP, and white board | Preview physics science of solid object | Book 1 chapter 1<br>Book 2 chapter 2,3<br>Book 3 chapter 2,3 |
| 3 | Understands Lubrication | Lubrication of full layer | Hydrostatic lubrication, | 100 | Presentation using proyector, | Preview fluid science | Book 1 chapter 2<br>Book 2 chapter 9 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | phenomenon full layer on hydrodynamic lubrication, mixture, layer squeeze and also Lubrication besides liquid. | | hydrodynamic lubrication, elastohydrodynamic lubrication, mixture lubrication, squis layer and lubrication of gas layer. | | OHP, and white board | | Book 3 chapter 6,7 |
| 4 | Understands initial character of Lubricant, starts from it is viscosity, additive effect and kinds of Lubricant types. | Lubricant | Viscosity and other, mineral lubricating oil, lube oil additives (anti-oxidants, corrosion inhibitors, anti-wear, extreme pressure, anti-foam and detergent), grease, synthetic Lubricant and solid lubricants. | 100 | Presentation using proyector, OHP, and white board | Preview fluid science | Book 1 chapter 3<br>Book 2 chapter 10<br>Book 3 chapter 5 |
| 5 | Understands Lubricant character is being operating. Its checking visually and also with laboratory test and its treatment.. | Lubricant in usage | Replacement period, visual examination, laboratory routine test (acid value, viscosity, additive depletion, testing of grease), treatment (contamination as result of wear, foaming and contamination of solid object) | 100 | Presentation using proyector, OHP, and white board | Maintenance engineering | Book 1 chapter 4<br>Book 2 chapter 9<br>Book 3 chapter 5 |
| 6 | Recognizes pads types generally and can choose correct pad for the certain application. . | Choosing of Pad | Pad base type, pads rubbing, sliding pad, hydrodynamic lubrication pad, pad failures and pad with process fluid Lubrication. | 100 | Presentation using proyector, OHP, and white board | Choice technique | Book 1 chapter 5 |
| 7 | Recognizes pad sliding is more detail because which | Sliding Pads | Design with sliding pad, choosing sliding pad | 100 | Presentation using proyector, OHP, and white | Faillure analysis | Book 1 chapter 6 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | at most applied, how to choose,the equivalence, type and kinds of failure. | | (clearance, class and fitting), Lubrication of sliding pad (the method and election), pad ' equivalent', and failure of sliding pad ( fatigue, Lubricant failure, contamination and deformation plastics). | | board | | |
| 8 | Middle Test of Semester ( UTS) | Meeting mayor subject of I up to VII | | 120 | | | |
| 9 | Understands mechanism a method or Lubrication is used occasionally at the certain application. | Lubrication methods | Ring and disk oilers at plain bearing, oil circulation system (oil treatment quality, contamination, degradation of Lubricant quality, water entrainment, foaming, warning and protector equipments), gear ( Lubrication and surface finish) and compressor cylinder repeatedly. | 100 | Presentation using proyector, OHP, and white board | Preview machine element | Book 1 chapter 7 |
| 10 | Understanding mechanism and failure cause of mineral Lubricant like fire and explosion. | Fire Danger and explosion with mineral lubricating oil | Explosion crankcase, burning of hydraulic system, burning lagging, burning of the air compressor and explosion, and explosion of high pressure pneumatic system. | 100 | Presentation using proyector, OHP, and white board | Work safety | Book 1 chapter 8 |
| 11 | Recognizes kinds of good seal applied for liquid and also for gas.. | Kinds of seal | Seal for dilution ( soft-packed glands and automatic packing of | 100 | Presentation using proyector, OHP, and white | Preview fluid science | Book 1 chapter 9 Book 1 chapter 14 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | reciprocating seals; ring ' O ' and seal mechanic for rotary), seal for gas ( clearance, labyrinth, liquid barrier, double mechanical, floating-bush and seal contact). | | board | | |
| 12 | Understands phenomenon wear starts from the mechanism, equation and abrasion types. | Wear | Abrasion mechanism, the relationship with other parameters, in practice, the generalizing, gain type of the particle (plate-shaped. ribbon-shaped, spherical and irregularly) and abrasion of various materials (metal, ceramic and polymer). | 100 | Presentation using proyector, OHP, and white board | Preview physis science | Buku 1 bab 10<br>Buku 2 bab 8<br>Buku 3 bab 4<br>Book 1 chapter 10<br>Book 2 chapter 8<br>Book 3 chapter 4 |
| 13 | Recognize kinds of problems solving relate to the tribology application. . | Election of solution tribology | Solutions at problem tribology for example environment aspect, burden, speed, boundaries tribology for burden and speed and its used | 100 | Presentation using proyector, OHP, and white board | Problem solver engineering | Buku 3 bab 8<br>Book 3 chapter 8 |
| 14 | Comprehends elementary a bulk material (original material without layer/coating), veneering and surface treatment that relate with tribology, because the character tribology of material can increased with veneering and or other surface treatment. | Material veneering | Base material, veneering and surface treatment for the tribology application: Base material (metal and blend, ceramic and cermets, ceramic-metal composite and solid lubrication, and self-lubricating solids), veneering and surface treatment (deposisi technique veneering, | 100 | Presentation using proyector, OHP, and white board | engineering | Book 2 chapter 13 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | surface treatment technique and election criterion of veneering material). | | | | |
| 15 | Understands a real mechanic component types which tightly related with the application of tribology, micron measure component at the tribology application. material processor equipments and the application of other industry so that can take care of, improve; repairs and designs accurately and correctness. | Components tribology in the usage | Tribology component used occasionally ( pad, seal, gears, cams and tappets, piston rings and electrical brushes), micro component, material processor ( cutting tools, grinding and lapping, forming processes and cutting fluids) and the industrial application ( machine automotive, gas turbine machine, railroads and equipments of magnetic storage). | 100 | Presentation using proyector, OHP, and white board | Application of engineering | Book 2 chapter14 |
| 16 | Final Exam Semester (UAS) | Meeting Matter of IX up to XV | | 120 | | | |

Reference book:


1. Summers-Smith, J.D., *An Introductory Guide to Industrial Tribology*, Mechanical Engineering Publications Ltd., London, 1994.
2. Bhushan, B., *Principles and Applications of Tribology*, John Wiley & Sons Inc., New York, 1999.
3. Halling, J., *Introduction to Tribology*, Wykeham Publications Ltd., London, 1976.
4. Rabinowich, E., *Friction and Wear of Materials*, John Wiley & Sons Inc., New York, 1995.
5. Stachowiak, G.W. and Batchelor, A.W., *Engineering Tribology*, Butterworth Heinemann, Boston, 2001.
6. Williams, J.A., *Engineering Tribology*, Oxford University Press, Oxford, 1994.
7. Hutchings, I.M., *Tribology: Friction and Wear of Engineering Materials*, Edward Arnold, London, 1992.
8. Arnell, R.D., Davies, P.B., Halling, J. and Whomes, T.L., *Tribology: Principles and Design Applications*, Springer-Verlag, New York, 1993.
9. Ludema, K.C., *Friction, Wear, Lubrication: A Textbook in Tribology*, CRC Press, Boca Raton, 1996.
10. Journal: *ASME Journal of Tribology, Tribology Letters, WEAR, Tribology International, TriboTest., ASME Journal of Applied Mechanics, Tribology Transactions of the STLE (Society of Tribologists and Lubrication Engineers), Surface and Coatings Technology, Proc. Instn. Mech. Eng. Journal of Tribology.*

# SET OF EVENT OF STUDY (SAP)

MAJOR SUBJECT TITLE : **INDUSTRION TRIBOLOGY**
SUBJECT TITLE CODE : TKM-487
SKS : 2
MEETING TIME : 100 MINUT
MEETING TO : I

A. PURPOSE OF INSTRUKSIONAL

**1.GENERAL** : Having completed this course student can analyze and solve tribology problem in industrial world.

**2.SPECIAL** : Student comprehends study of tribology definition, developing history and its influence in science and technology advancement till now.

**B.PERFORMANCE SOFT SKILL** : Student comprehends about tribology history.

**C. STUDY METHOD** : presentation course by projector video, OHP and panel writes

**D. DISCUSSION FUNDAMENTAL** : introducing tribology industry

**E. DISCUSSION FUNDAMENTAL SUB** : tribology drfnition, event of tribology, history of tribology, problem solver for tibology case, micro-nano of tribology, and application in industral world.

F. SCHOOL ACTIVITY

| NO | STEP | TIME (MINUTE) | TEACHING ACTIVITY | STUDENT ACTIVITY | MEDIAN AND STUDY EQUIPMENT |
|---|---|---|---|---|---|
| 1 | INTRODUCTION | 5 | Submits lecturing agenda | LISTENING | Listens Projector video, OHP and blackboard |
| 2 | PRESENTATION | 70 | Submits and explains teaching Major subject | LISTENING | Listens Projector video, OHP and blackboard |
| 3 | CONCLUSION | 25 | Discussion and gives training | DISCUSION AND EXERCISE | Listens Projector video, OHP and blackboard |

G. EVALUATION : THE RESULT OF DISCUSION AND EXERCISE

H. BIBLIOGRAPHY :


1. Jonhson, K.L., *Contact Mechanics*, Cambridge University Press, Cambridge, 1985.
2. Fischer-Cripps, A.C., *Introduction to Contact Mechanics*, Springer-Verlag Inc., New York, 2000.
3. Goryacheva, I.G, *Contact Mechanics in Tribology*, Kluwer Academic Publishers, London, 1998.
4. Journal: *ASME Journal of Tribology, Tribology Letters, WEAR, Tribology International, TriboTest., ASME Journal of Applied Mechanics, International Journal of Solid and Structure.*


Catatan:
Pertemuan ke-II sampai dengan Pertemuan ke-XVI SAP nya sama dengan perbedaan pada tujuan instruksional dan kepustakaan seperti yang termaktub pada Garis-Garis Besar Program Pembelajaran (GBPP).