No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
			Laguerre and its normalization 4. Explicit form of hydrogen atom electron wave function form 5. Hydrogen atom electron Energy levels			

Reference:

[1] Richard L. Liboff, 1992, *Introductory Quantum Mechanics*, second edition, Addison-Wesley Publishing Company.
[2] C. Cohen Tanoudji, Bernard Diu and Frank Laloe, 1977, *Quantum Mechanics*, second edition, Jhon Wiley and Sons.
[3] Youv Peleg, Reuven Pnini and Elyahu Zaakur. 1998, *Quantum Mechanics*, Schaum out lines McGraw-Hill
[4]. Anwar Dhani, 1980, *Mekanika Kuantum*, Penerbit Jurusan Fisika, FIPA UGM, Yogyakarta,

OUTLINES OF LEARNING PROGRAM

Course : NUMERIC ANALYSIS DAN PROGAMMING

Course Code, credit : PAF 216, 2/ III

Description : This course covers the error analysis, methods for finding the roots of an equation, methods for solving linear algebra equation, method of curve. Pascal programming include looping, Selection of conditions, procedure, function, array, file and their application on numeric Analysis.

General Objectives: At the end of course you should be able to

- Analyze the errors
- Find the roots of an equation
- Solve the equation of linear algebra and be able to solve adaptation of curve
- Make the programs application of the numeric analysis

Prerequisite Course : PAF 211 (Fisika Matematika I)

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
1.	At the end of course you should be able to describe the concepts related to error and types of error and be able to analyze them .	Error analysis	1. Significant Digits 2. Accuracy and precision 3. Rounding error 4. Chopping error 5. Error propagation 6. Total numeric error	100	Lecture, discussion, home works	
2.	At the end of course you should be able to describe various method of closed method for finding roots of an equation.	Closed methode	1. Graph method 2. Bisection Method 3. False-Position Method 4. Incremental finding and Determination of pre guess	100	Lecture, discussion, home works	
3.	At the end of course you should be able to describe various method of Opened Methods for finding roots of an equation.	Opened Methods	1. Fixed-point iteration 2. Newton - RaphSon method 3. Secant method	100	Lecture, discussion, home works	

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
4.	Evaluation I			100		
5.	At the end of course you should be able to describe the structure and the elements of Pascal program and be able to desribe data input/output statements	Structure and elements of Pascal Program	1. Program structures in Pascal 2. Declaration 3. Program elements in Pascal 4. Entering data 5. Displaying data	100	Lecture, discussion, home works	
6.	At the end of course you should be able to make a program with looping statement and selection of condition and be able to apply on the numeric cases.	Looping and Selection of Conditions	1. The FOR loop structure 2. While-Do loop structure 3. Repeat - Until Structure 4. IF Statement 5. Case Statement	100	Lecture, discussion, home works	
7.	At the end of course you should be able to make a program with procedure and function statement and be able to apply on numeric cases	Procedure and Function	1. Parameters in procedure 2. Nested Procedure 3. Standard Procedure 4. Parameters in function 5. Nested function 6. Standard Function	100	Lecture, discussion, home works	
8.	At the end of course you should be able to make a program with array and file statement and be able to apply on numeric cases	Array and File	1. Array 2. Untyped File 3. Typed File	100	Lecture, discussion, home works	
9.	Evaluation II			100		
10.	At the end of course you should be able to describe the Gauss elimination and Gauss-Saidel method on the linier equation systems	Gauss elimination and Gauss-Saidel method	1. Naive Gauss Ellimination 2. Method of Trap Gauss elimination 3. Improvement techniques of Gauss elimination method 4. Matrix Inversion 5. Gauss-Saidel Method	100	Lecture, discussion, home works	
11.	At the end of course you should be able to describe the LU Decomposition method on the linier equation systems	LU Decomposition method	1. Naïve LU Décomposition 2. Gauss Ellimination 3. LU Décomposition	100	Lecture, discussion, home works	

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
			4. Crout Decomposition			
12.	At the end of course you should be able to describe the various least square method for the curve fitting	Least Square Method	1. Linear regresion 2. Polynomial regression 3. Double Linear Regression	100	Lecture, discussion, home works	
13.	At the end of course you should be able to describe the various interpolation methods for the curve fitting	Interpolating method	1. Interpolating Polynomial 2. Divided-difference of Newton 3. Lagrange Interpolating Polynomial 4. Coefficients of a interpolated polynomial	100	Lecture, discussion, home works	
14.	Evaluation III					

Reference

Chapra, S.C. and Canale, R.P., 1988, *Numerical Methods For Engineers*, 2nd Edition, McGraw-hill, Inc, England

Matrix of order n

OUTLINES OF LEARNING PROGRAM

Course : NUMERIC ANALYSIS DAN PROGAMMING LAB

Course Code, credit : PAF 216P, 2/ III

Description : These laboratories practice course of the Numeric Analysis and programming. This Practical cover Method of find the roots of a polynomial (Method of fixed point Iteration, Newton–Raphson and Secant method), linear interpolating, operations of Matrix, and solution of linear algebra with Gauss-Seidel method

General Objectives: : At the end of course you should be able to make a program to solve problems of physical system (phenomenon of physics) related to Numeric Analysis using Pascal Language, as follow : to find the root of a polynomial, Linear Interpolation, Operation Matrix, and solution of Linear algebra

Prerequisite Course : PAF 216* (Analisis numerik dan pemrograman)*

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
1.	At the end of course you should be able to make a program for finding of a polynomial	Method for finding the roots of a polynomial	1. Fixed point Titik iteration 2. Newton_Raphson method 3. Secant method	200	Practicum	
2.	At the end of course you should be able to make a program for linear interpolating of a function	Linier Interpolation	1. First Order linier Interpolation 2. N Order Linier Interpolation	200	practicum	
3.	At the end of course you should be able to make a program for matrix operations.	Operation of Matrix	1. Transpose 2. Matrix multiplication 3. Adam Moulton Method	100	practicum	

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
			4. Runge Kutta Method			
4.	At the end of course you should be able to make a program for solution of linear algebra equations	Linier Algebra equation	1. Gauss-Seidel Method 2. Crammer Method	100	practicum	

OUTLINES OF LEARNING PROGRAM

Course : **Thermodynamics**

Course Code, credit : PAF 222, 3 sks/IV

Description : This course covers basic concepts and definitions, properties of pure substances, fisrt and second law thermodynamics for opened and closed systems, entropy and avaibility

General Objectives: : After completing this course the students will understand the underlying principles of thermodynamics:
- properties of simple compressible fluids (use of tables included),
- first and second law of thermodynamics for opened and closed systems,
- Concepts of entropy and availability.

Prerequisite Course : Fisika dasar I, Matematika Dasar I

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
- 1	At the end of course you should be able • Differentiate the Macroscopic and microscopic description • Describe the basic concepts and definitions	basic concepts and definitions	1. Macroscopic and microscopic description 2. System state, and properties of system 3. Concept of pressure and volume 4. Concept of equilibrium 5. Concept of process 6. Concept of temperature and Zeroth law thermodynamics 7. Equation of state of ideal gas	250	Lecture, discussion, home works	

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
2	At the end of course you should be able to • state the First Law and to define heat, work, and the difference between various forms of energy • Describe the heat capacity • Analyze the thermodynamics problems using first law • Analyze the processes for an ideal gas using first law	Heat and the first law thermodynamics	1. p-V Work 2. Heat 3. First law thermodynamics 4. Internal energy 5. Heat capacity 6. Entalphi 7. Internal energy of gas 8. Processes for an Ideal gas 9. Quasistatic adiabatic processes for an ideal gas	200	Lecture, discussion, home works	
3	Exercises			100		
4	Quiz I			100		
5	At the end of course you should be able • Define the pure substances • Describe the equilibrium phase • Mention equation of state for pure substances • Draw the surface of p-V-T of pure substances • Read the tables of thermodynamic properties of pure substances and be able to use for solving simple thermodynamics problems.	Properties of pure substance	1. Pure substances 2. Phase Change 3. Internal energy of gas 4. P-V-T Surface 5. Thermodynamics Tables 6. Processes for gas in closed system	150	Lecture, discussion, home works	
6	At the end of course you should be able apply the steady-flow energy equation or the First Law of Thermodynamics to a system of thermodynamic components (turbine, nozzle, etc)	Analysis of first law of thermodynamics for control volume	1. Principle of mass conservation for control volume 2. Principle of energy conservation for control volume 3. steady-flow energy equation, 4. Some Applications 5. unsteady flow process	150	Lecture, discussion, home works	
7	Exercises			100		

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
8	Quiz II			100		
9	At the end of course you should be able to • apply ideal cycle analysis to simple heat engine cycles • estimate thermal efficiency and work • Explain the physical content and implications of the second law in non-mathematical terms • Define entropy • Calculate entropy change for various processes	Second law of thermodynamics and Entropy	1. Heat engine and refrigerator 2. statements of the second law of thermodynamics 3. Reversible and irreversible processes 4. Carnot cycle 5. Efficiency of reversible engine 6. Thermodynamics temperature scale and absolute zero 7. Entropy 8. T-s and h-s Diagram 9. Entropy change in reversible processes 10. two important relations 11. Entropy change for an ideal gas 12. isentropic process for an ideal gas 13. Entropy change in incompressible substance	300	Lecture, discussion, home works	
10	At the end of course you should be able toUse entropy calculations as a tool for evaluating irreversibility (lost work) in engineering	Ireversibility and exergy	1. Entropy change in irreversible process 2. Principle of Entropy increase 3. production of entropy in closed system 4. Second law of thermodynamics for control volume	300	Lecture, discussion, home works	

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
			5. processes of steady flow, steady state and processes of homogenous state 6. Isentropic efficiency 7. Helmhotz and Gibb free energy 8. Exergy 9. Exergy balance for control volume 10. Efficiency and effectivity of second law			
	Exercises			100		
	Final Exam			100		

Referensi

1. .Holman, J.P, 1988. *Thermodynamics*, McGraw-Hill International Edition, 4th ed. Singapore, pp 780.
2. J. Van Wylen, G and Sonntag, R.E, 1985. *Fundamental of Clasiccal Thermodynamics. 3rd ed*, John Wiley & Son, Canada, pp 722
3. Lee, J.F and Sears, F.W. 1963. *Thermodynamics*, 2nd, Addison-Wesley Publishing Company, Inc, Massachusetts, USA
4. Khuriati, A, 2004, Dasar-dasar Termodinamika, buku pegangan kuliah
5. Zemansky, M.W and Dittman, R.H,1982 Kalor dan Termodinamika. Edisi ke-2 Terjemahan oleh The How Liong 1986, Institut Teknologi Bandung, Bandung. 613 hal.

OUTLINES OF LEARNING PROGRAM

Course : **Computational Physics (Lab)**

Course Code, credit : PAF 213P 3 / V

Description : This practical corresponds to material in the computational physics lecture course. It provides the opportunity to develop programming skill. There are six modules, each taking 100 minutes, as follow: Derivative of a function, Definite integral, Solution of first and second order Differential Equation, Special function, and eigen value of a matrix

General Objectives: : At the end of practical you should be able to make the programs for solving important physical problems with Pascal language

Prerequisite Course : PAF 213 (Fisika Komputasi)*

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
1.	At the end of practical you should be able to make the programs for calculating derivative of a function	The Derivative of a function	1. First Derivative. 2. Second Derivative	100		
2.	At the end of practical you should be able to make the programs for solving definite integral of a function	Definite Integral	1. Trapezium Rule 2. The 1/3 Simpson Rule 3. The 3/8 Simpson Rule 4. Bode Rule	100		

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
3.	At the end of practical you should be able to make the programs for solving first order Differential Equation	Solution of Differential Equation of first order	1. Euler Method 2. Adam Boshford Method 3. Adam Moulton Method 4. Runge Kutta	100		
	At the end of practical you should be able to make the programs for solving second order Differential Equation	Solution of Differential Equation of second order	1. Euler Method 2. Adam Boshford Method 3. Adam Moulton Method 4. Runge Kutta	100		
	At the end of practical you should be able to make the programs for solving special function	Special Functions	1. Hermite Function 2. Bessel Function 3. Lagendre Function 4. Laguare Function	100		
1	At the end of practical you should be able to make the programs for calculating eigen value of a matrix	Eigen value of a matrix	1. Method of the Approximation for Matrix of 2-order 2. Method of the Approximation for matrix of n- order	100		

Reference:

Chapra, S.C. dan Canale, R.P., 1988, *Numerical Methods For Engineers*, 2nd Edition, McGraw-hill, Inc, England

OUTLINES OF LEARNING PROGRAM

Course : **NUCLEAR PHYSICS**

Cource code, credit : PAF 311, 2/ V

Description : This course offers properties, Radioactivity, and Nuclear Reaction in atomic nucleus base phenomenon symptom, experiment, and also prediction of the result of theory calculation

General Obyectives : At the end of course you should be able to describe nucleon concepts and principles base quantum theory and simple electromagnetics theory

Prerequiste : PAF 214 (Modern Physics)

No.	Spesial Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
1	At the end of course you should be able to describe the properties of nucleus, nucleon structure model, binding energy dan nuclear force, and its problems solving.	Nuclear Structure	1. Properties of static nuclear (radius, mass, abundance, charges distribution)	3X100		[1]:230-260 [2]:384-473 [3]:916-942 [4]:3-18; 110-178; 354-387; 435-471. [5]: 44-149
			2. Energy binding and Nuclear force	2X100		IDEM
			3. Models of nuclear	1X100		IDEM
2	At the end of course you should be able to describe the radiation types, radioactivity problem solving and detecting techniques	Radioactivity	1. Radioactivity 2. Decay of alfa, beta dan gamma rays 3. Decay conservation law 4. Halftime and decay speed 5. Decay chain	6X100		[1]:230-260 [2]:384-473 [3]:916-942 [4]:19-77; 179- 353 [5]: 160-361

No.	Spesial Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
			6. Detecting radiation 7. Applications			
3	At the end of course you should be able to describe the types of nuclear reactions, problem solving, and its applications	Nuclear reactions	1. Nuclear reaction, 2. Nuclear Fission, 3. Nuclear Fusion 4. Nuclear reactors	2X1		[1]:265-292 [3]:943-972 [4]:78-109 [5]:378-431

Reference:

[1] Krane, K.S., ,*Modern Physics*, 1983, John Wiley & Sons
[2] Beiser, A., *Concepts of Modern Physics*, 5th Edition, 1995, McGraw-Hill, Inc., New York.
[3] Giancoli, D..C., *Physics*, 5th ed., 1998, Prentice Hall, New Jersey.
[4] * Atam P Arya, *Fundamental of Nuclear Physics*, 1966, Allyn and Bacon Inc. Boston.
[5] * Kenneth S. Krane, *Introductory Nuclear Physics*, 1988,John Wiley and Sons,.

OUTLINES OF LEARNING PROGRAM

Course	:	**Quantum Physics I**
Course Code, credit	:	PAF 312, 2 SKS/VI
Description	:	This course covers the quantization concept, function and operators, Hilbert's space, expectation values, Heissenberg uncertainty, Schrodinger equation, application of Schrodinger equation for free particle, particle in box, harmonic oscillator, hydrogen atom, complex atoms and angular momentum.
General Objectives:	:	At the end of course you should be able to describe about concepts, definitions dan apllication of quantum physics, correspondence quantum mechanics to classical mechanics
Prerequisite Course	:	PAF 214 (Modern Physics), PAF221(Mathematical Physics II)

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
	At the end of course you should be able to 1. Describe the concepts related to Approach and introductory of Physics Quantum 2. Describe the definition and operator function of hermitian, physical meaning of wave function, understanding of Schroedinger equation, applications of free particles in one dimension	Quantum physics approach and introduction	1. Blackbody Radiation 2. Photoelectric effects 3. Quantum Theory for atomic energy 4. De Broglie Hypothesis and Davison-Germer Experiment 5. Heisenberg Uncertainty 6. Born.wave probability 7. Postulate of Quantum Mechanics 8. Hermitian Operators 9. Wave functions 10. Schroedinger equation 11. Particle current density	2 x 100	Lecture, discussion, homeworks	1,2,3
	At the end of course you should be able to solve and interpret the	Applications of Schroedinger equation	1. The infinite well potential in one dimension : case $E<V_o$	5 x 100	Lecture, discussion,	1,2,3

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	Referenc es
1	2	3	4	5	6	7
	results related to the applications of One Dimension Schroedinger Problem Applications	problems in one dimension	2. The Potential Step 3. Finite Potential in one dimension case $E>V_0$ 4. The Potential Step 5. Application of Potential barrier, Alfa decay, NH_3 molecule, Diode Tunnel 6. Simple harmonic Oscilator 7. Solution of SHO and its interpretation 8. Application of SHO.		homeworks	
7.	At the end of course you should be able to describe Heissenberg uncertainty	Heissenberg uncertainty	1. Expectation Values Concept 2. Operator Concept in quantum mechanics 3. Formulation of Heissenberg uncertainty formula 4. Consequence of Heissenberg. uncertainty principle	2 x 50 minutes	Lecture, discussion, homeworks	4 pages: 18-24
8.	At the end of course you should be able to describe the Harmonic Oscillators in quantum mechanics	Harmonic Oscilator	1. Tingkat-tingkat energi oscillator harmonic. 2. Hamiltonian harmonic oscillator 3. Schrodinger equation for the harmonic oscillator and variable separation method 4. Hermite Special Function and its normalization 5. Expllicit form of harmonic oscillator wave function	2 x 50 minutes	Lecture, discussion, homeworks	4, pages: 29-34
9.	At the end of course you should be able to describe hydrogen atom concepts	**Hydrogen Atom**	1. Electron Hamiltonian 2. Schrodinger equation for the hydrogen atom system and variable separation method 3. Harmonic Function, Special Function of Legendre and	2 x 50 minutes	Lecture, discussion, homeworks	4, pages: 35-38

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	Referenc es
1	2	3	4	5	6	7
			Laguerre and its normalization 4. Explicit form of hydrogen atom electron wave function form 5. Hydrogen atom electron Energy levels			

Reference:

[1] Richard L. Liboff, 1992, *Introductory Quantum Mechanics*, second edition, Addison-Wesley Publishing Company.
[2] C. Cohen Tanoudji, Bernard Diu and Frank Laloe, 1977, *Quantum Mechanics*, second edition, Jhon Wiley and Sons.
[3] Youv Peleg, Reuven Pnini and Elyahu Zaakur. 1998, *Quantum Mechanics*, Schaum out lines McGraw-Hill
[4]. Anwar Dhani, 1980, *Mekanika Kuantum*, Penerbit Jurusan Fisika, FIPA UGM, Yogyakarta,

OUTLINES OF LEARNING PROGRAM

Course	:	**EXPERIMENTAL PHYSICS I**
Course Code, credit	:	PAF 315, 2 SKS/V
Description	:	These experiments demonstrate key aspects of physics covered in modern physics lecture courses, as follow: Experiment of millikan oil drop, Experiment of photoelectric effect, Experiment of Frank, Hertz Experiment of Michelson Interferometer, Experiment of e/m, Experiment of atom Spectroscopic, and Experiment of Rutherford
General Objectives:	:	At the end of practical you should be able to describe and to use the instruments related to experiment with concepts in modern Physics
Prerequisite Course	:	PAF 213 (Elektronika Dasar), PAF214(Fisika Modern)

No.	Special Objectives	Topics	Sub Topics	Time (menits)	Learning experience / methode	Referenc es
1	2	3	4	5	6	7
1.	At the end of course you should be able to describe and to use the instruments of millikan oil drop Experiment	Experiment of millikan oil drop		2x 50	experiment	
2.	At the end of course you should be able to describe and to use the instruments of photoelectric effect Experiment	Experiment of photoelectric effect		2x 50	experiment	
3.	At the end of course you should be able to describe and to use the instruments of Frank Hertz experiment	Experiment of Frank Hertz		2x 50	experiment	
4.	At the end of course you should be able to describe and to use the instruments of Michelson Interferometer Experiment	Experiment of Michelson Interferometer		2x 50	experiment	
5.	At the end of course you should be able to describe and to use the instruments of e/m Experiment	Experiment of e/m		2x 50	experiment	
6.	At the end of course you should be able to describe and to use the instruments of atom	Experiment of atom Spectroscopic		2x 50	experiment	

No.	Special Objectives	Topics	Sub Topics	Time (menits)	Learning experience / methode	References
1	2	3	4	5	6	7
	Spectroscopic Experiment					
7.	At the end of course you should be able to describe and to use the instruments of Rutherford scattering Experiment	Experiment of Rutherford scattering		2x 50	experiment	

Reference:

[1] Krane, K.S., 1983, *Modern Physics*, John Wiley & Sons
[2] Beiser, A., 1995, *Concepts of Modern Physics*, 5th Edition, McGraw-Hill, Inc., New York.
[3] Giancoli, D..C., 1998, *Physics*, 5th ed., Prentice Hall, New Jersey.
[4] Tipler, P.A., 1991, *Physics*, 3rd ed., Worth Publishers, New York.
[5] Frederick J. Bueche, 1995, *Physics For Scientists And Engineers*, McGraw-Hill

OUTLINES OF LEARNING PROGRAM

Course : Statistical Physics

Course Code, credit : **PAF 313, 2 SKS**

Description : The course include Statistical Physics approach, canonical ensemble, , grand canonical ensemble, Quantum gases, Fermi-Dirac Statistics , Bose-Einstein Statistics.

General Objectives: : At the end of course you should the basics or great foundation to develop the modern science and/or to apply to modern technologie

Prerequisite Course : PAF 222 (Thermodynamics)

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
1	At the end of course you should be able • Describe the definition and difference of macroscopic state microscopic • Understand the formulation of statistical burden of microstate • Describe the requirements of maximum entropy of equilibrium state • Define the opened systems and closed • Describe the microscopic Ensemble Definition and Partition function • Describe the definition of heat reservoir and how an equilibrium system in reservoir • Describe the formulation of canonical Ensemble which differentiate from micro canonic Ensemble • describe the distribution of Maxwell-Boltzmann	Statistical Physics approach	1. Macroscopic & microscopic state 2. Statistical burden of microstate 3. Principal of maximum entropy 4. Equilibrium at opened system and closed 5. Microscopic ensemble 6. Partition function 7. Equilibrium System in thermostat (reservoir) 8. Canonical ensemble 9. Distribution of Maxwell-Boltzmann	4 x 150		[1]:18-52 [2]: 25-26 128 – 139.
2	At the end of course you should be able to	Canonical ensemble	1. Paramagnetic Nature of	4 x 150		[1]:54-

	understand and describe: • The Definition of Ensemble density and the requirement referred as Canonical Ensemble • the relationship between canonical Ensemble to paramagnetic nature of solid • The Definition of internal energy in and Helmholtz free energy and their formulas • Definition and also formula of capacities of heat attributed to entropy and heat attributed to Helmholtz free energy • Definition of density of states and situation theory • Incompatibility of Einstein Heat Capacity Theory to experimental result which repaired with Debye. Heat capacity theory		solid 2. Internal Energy 3. Helmholtz free energy 4. Heat Capacity and entropy 5. Density of states 6. Theory Situation 7. Einstein's Heat Capacity Theory 8. Debye Heat Capacity Theory.			177 [2]: 75-85 139 – 150
3	At the end of course you should be able to understand and describe: • The Definition grand canonical Ensemble to the amount of particle a macroscopic system • The Formulation of grand Partition function (classic) • The System criterion can be assumed classical • The Definition of state equation and entropy of grand canonical Ensemble • The Definition of Gibbs Free energy as Gibbs thermodynamics potential or Gibbs chemical potential • The Definition of real gas and virial expansion of estranged gas pressure • The Definition of critical point of a liquid	Grand canonic ensemble	1. Partition function 2. classic System Criterion 3. Equation Of State 4. Entropy 5. Free energy of Gibbs 6. Potential chemistry and thermodynamics 7. Real gases 8. Expansion Virial 9. Critical points	3 x 150		[1]:179-240. [2]:86–105 151–169 [3]:314 - 323

	gas transition					
4	At the end of course you should be able to understand and describe: • The Difference of real gas and quantum gas and their statistical distribution • The Definition of Partition Function for the quantum gas • The difference between two statistical distributions of quantum gas that is Fermi-Dirac distribution and Bose-Einstein, Fermion and Boson particle definition.	Quantum Gases	1. Partition Function 2. Fermi-Dirac Distribution 3. Bose-Einstein distribution	1 x 150		[2]:46–49. 60–62. [3]:577-585
5	At the end of course you obtain the knowledge about • The Difference of classic limit concepts with free electron model of fermi-Dirac statistics of supporting result of experiment • The application of Fermi-Dirac Statistics on electron specific heat susceptibility magnetic and white cretinous Star, neutron star and Black Hole	Fermi-Dirac statistics	1. Classic Limit 2. Free electron model 3. Electron Heat capacity 4. Magnet Susceptibility 5. White Cretinous Star, neutron star and Black Hole	2 x 150		[1]:241-277 [2]: 63 – 74. [3]:343-351
6	Student expected to obtain knowledge concerning Bose-Einstein distribution and its application on spectrum of black body radiation and crystal specific heat theory	Bose- Einstein Statistics	1. Bose Einstein Gases 2. Spectrum of black body radiation 3. crystal capacity theory	2 x 150		[1]:278-304 [2]: 49 – 59 [3]:328-342

References:

[1] Huang, Kerson, 1987, *Statistical Mechanics*, second edition, John Wiley & Sons.

[2] Pointon, A. J., 1967, *An Introduction to Statistical Physics for Students*, Longman Group LTD, London.

[3] Beiser, Arthur, 1987, *Konsep Fisika Modern*, terjemahan The Houw Liong, edisi keempat, Penerbit Erlangga, Jakarta.

OUTLINES OF LEARNING PROGRAM

Course : **SENSORS AND TRANSDUCERS**

Course Code, credit : PAF 316

Description : This course studies the sensors and transducers. This cover: data acquisition, sensor characteristics, physical principles of sensing, position, level and displacement sensor. Next topics include the occupancy and moving objects, velocity, acceleration, strain, force, pressure, flow, sound, humidity sensors, light, radiation, electromagnetic field detector, and temperature sensor.

General Objectives: At the end of course you should be able to

- describe the data acquisition system, sensor characteristics, and physical principles of sensing and be able to give the examples of their applications
- Describe the characteristics along and the physical principles of position, velocity, acceleration, strain, force, pressure, flow, sound, humidity sensors, light, radiation, electromagnetic field detector, and temperature sensor and be able to give the examples of their applications.

Prerequisite Course : PAF 213 (Elektronika Dasar)

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
1	At the end of course you should be able to describe the data acquisistion and its applications	data acquisistion	1. Sensors, signals, and Systems 2. Sensor classification 3. Units of Measurements.	100	Lecture, discussion, homeworks	
2	At the end of course you should be able to describe the sensors characteristics and be able to give the examples	Sensor characteristics	1. Transfer Function, span 2. Accuracy and hysterisis 3. Saturation repeatability 4. Dead Band,	100		

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
			resolution 5. Special properties, output impedance 6. Dynamic Characteristics			
3	At the end of course you should be able to describe the Physical prinsiples of sensing and be able to give its applications	Physical prinsiples of sensing	1. Electrostatic 2. capacitance, magnetism 3. Induction, resistance 4. Piezoelektric Effect 5. Pieroelektric Effect 6. Hall, Pieltier, and 1. Seeback. Effect		Lecture, discussion, homeworks	
4	Evaluation I			100		
5	At the end of course you should be able to describe the principles of position, lvel, and displacement sensors and be able to give the examples .	Position, level, displacement sensors	1. Potentiometric sensors 2. Gravitational sensors 3. Inductive, magnetic sensors 4. optical Sensors 5. Ultrasonic Sensors 6. Magnetostrictive Detector	100	Lecture, discussion, homeworks	
6	At the end of course you should be able to describe the principles of detectors of occupancy and moving objects, the velocity and acceleration sensor and be able to give the examples .	detectors of occupancy and moving objects, velocity and acceleration sensor	1. Ultrasonic Sensors. 2. Microwave Detectors 3. capacitive Detectors 4. Triboelektric Detectors 5. Optoelectronic Detector 6. Electromagnetic velocity Sensor	100	Lecture, discussion, homeworks	

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
			7. Acceleration sensor 8. Piezoelectric cables			
7	At the end of course you should be able to describe the principles of force, strain, and pressure sensors and be able to give the examples	force, strain, and pressure sensors		100	Lecture, discussion, homeworks	
8	At the end of course you should be able to describe the principles of flow sensor and be able to give the examples	flow sensor		100	Lecture, discussion, homeworks	
9	Evaluation II			100		
10	At the end of course you should be able to describe the principles of acoustics sensor and be able to give the examples	Acoustics Sensor		100	Lecture, discussion, homeworks	
11	At the end of course you should be able to describe the principles of humidity sensor and be able to give the examples	Humidity Sensor		**100**	Lecture, discussion, homeworks	
12	At the end of course you should be able to describe the principles of light detector and be able to give the examples	Light detector		**100**	Lecture, discussion, homeworks	
13	At the end of course you should be able to describe the principles of radiation and field electromagnetic detector and be able to give the examples	radiation and field electromagnetic detector		**100**	Lecture, discussion, homeworks	
14	At the end of course you should be able to describe	temperature		**100**	Lecture,	

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
	the principles of temperature sensor and be able to give the examples	sensor			discussion, homeworks	

OUTLINES OF LEARNING PROGRAM

Course	:	**EXPERIMENTAL PHYSICS I**
Course Code, credit	:	PAF 315, 2 SKS/V
Description	:	These experiments demonstrate key aspects of physics covered in modern physics lecture courses, as follow: Experiment of millikan oil drop, Experiment of photoelectric effect, Experiment of Frank, Hertz Experiment of Michelson Interferometer, Experiment of e/m, Experiment of atom Spectroscopic, and Experiment of Rutherford
General Objectives:	:	At the end of practical you should be able to describe and to use the instruments related to experiment with concepts in modern Physics
Prerequisite Course	:	PAF 213 (Elektronika Dasar), PAF214(Fisika Modern)

No.	Special Objectives	Topics	Sub Topics	Time (menits)	Learning experience / methode	References
1	2	3	4	5	6	7
1.	At the end of course you should be able to describe and to use the instruments of millikan oil drop Experiment	Experiment of millikan oil drop		2x 50	experiment	
2.	At the end of course you should be able to describe and to use the instruments of photoelectric effect Experiment	Experiment of photoelectric effect		2x 50	experiment	
3.	At the end of course you should be able to describe and to use the instruments of Frank Hertz experiment	Experiment of Frank Hertz		2x 50	experiment	
4.	At the end of course you should be able to describe and to use the instruments of Michelson Interferometer Experiment	Experiment of Michelson Interferometer		2x 50	experiment	
5.	At the end of course you should be able to describe and to use the instruments of e/m Experiment	Experiment of e/m		2x 50	experiment	
6.	At the end of course you should be able to describe and to use the instruments of atom	Experiment of atom Spectroscopic		2x 50	experiment	

No.	Special Objectives	Topics	Sub Topics	Time (menits)	Learning experience / methode	References
1	2	3	4	5	6	7
	Spectroscopic Experiment					
7.	At the end of course you should be able to describe and to use the instruments of Rutherford scattering Experiment	Experiment of Rutherford scattering		2x 50	experiment	

Reference:

[1] Krane, K.S., 1983, *Modern Physics*, John Wiley & Sons
[2] Beiser, A., 1995, *Concepts of Modern Physics*, 5th Edition, McGraw-Hill, Inc., New York.
[3] Giancoli, D..C., 1998, *Physics*, 5th ed., Prentice Hall, New Jersey.
[4] Tipler, P.A., 1991, *Physics*, 3rd ed., Worth Publishers, New York.
[5] Frederick J. Bueche, 1995, *Physics For Scientists And Engineers,* McGraw-Hill

OUTLINES OF LEARNING PROGRAM

Course : **SENSORS AND TRANSDUCERS**

Course Code, credit : PAF 316

Description : This course studies the sensors and transducers. This cover: data acquisition, sensor characteristics, physical principles of sensing, position, level and displacement sensor. Next topics include the occupancy and moving objects, velocity, acceleration, strain, force, pressure, flow, sound, humidity sensors, light, radiation, electromagnetic field detector, and temperature sensor.

General Objectives: :
At the end of course you should be able to
- describe the data acquisition system, sensor characteristics, and physical principles of sensing and be able to give the examples of their applications
- Describe the characteristics along and the physical principles of position, velocity, acceleration, strain, force, pressure, flow, sound, humidity sensors, light, radiation, electromagnetic field detector, and temperature sensor and be able to give the examples of their applications.

Prerequisite Course : PAF 213 (Elektronika Dasar)

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
1	At the end of course you should be able to describe the data acquisistion and its applications	data acquisistion	1. Sensors, signals, and Systems 2. Sensor classification 3. Units of Measurements.	100	Lecture, discussion, homeworks	
2	At the end of course you should be able to describe the sensors characteristics and be able to give the examples	Sensor characteristics	1. Transfer Function, span 2. Accuracy and hysterisis 3. Saturation repeatability 4. Dead Band,	100		

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
			resolution 5. Special properties, output impedance 6. Dynamic Characteristics			
3	At the end of course you should be able to describe the Physical prinsiples of sensing and be able to give its applications	Physical prinsiples of sensing	1. Electrostatic 2. capacitance, magnetism 3. Induction, resistance 4. Piezoelektric Effect 5. Pieroelektric Effect 6. Hall, Pieltier, and 1. Seeback. Effect		Lecture, discussion, homeworks	
4	Evaluation I			100		
5	At the end of course you should be able to describe the principles of position, lvel, and displacement sensors and be able to give the examples .	Position, level, displacement sensors	1. Potentiometric sensors 2. Gravitational sensors 3. Inductive, magnetic sensors 4. optical Sensors 5. Ultrasonic Sensors 6. Magnetostrictive Detector	100	Lecture, discussion, homeworks	
6	At the end of course you should be able to describe the principles of detectors of occupancy and moving objects, the velocity and acceleration sensor and be able to give the examples .	detectors of occupancy and moving objects, velocity and acceleration sensor	1. Ultrasonic Sensors. 2. Microwave Detectors 3. capacitive Detectors 4. Triboelektric Detectors 5. Optoelectronic Detector 6. Electromagnetic velocity Sensor	100	Lecture, discussion, homeworks	

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
			7. Acceleration sensor 8. Piezoelectric cables			
7	At the end of course you should be able to describe the principles of force, strain, and pressure sensors and be able to give the examples	force, strain, and pressure sensors		100	Lecture, discussion, homeworks	
8	At the end of course you should be able to describe the principles of flow sensor and be able to give the examples	flow sensor		100	Lecture, discussion, homeworks	
9	Evaluation II			100		
10	At the end of course you should be able to describe the principles of acoustics sensor and be able to give the examples	Acoustics Sensor		100	Lecture, discussion, homeworks	
11	At the end of course you should be able to describe the principles of humidity sensor and be able to give the examples .	Humidity Sensor		**100**	Lecture, discussion, homeworks	
12	At the end of course you should be able to describe the principles of light detector and be able to give the examples .	Light detector		**100**	Lecture, discussion, homeworks	
13	At the end of course you should be able to describe the principles of radiation and field electromagnetic detector and be able to give the examples	radiation and field electromagnetic detector		**100**	Lecture, discussion, homeworks	
14	At the end of course you should be able to describe	temperature		**100**	Lecture,	

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
	the principles of temperature sensor and be able to give the examples	sensor			discussion, homeworks	

OUTLINES OF LEARNING PROGRAM

Course	:	MODERN OPTICS
Course Code, credit	:	PAF 323, 2 SKS/VI
Description	:	This course covers the modern optics concepts and its applications, optical concept using modern theory related to growth of optics nowadays and its application. The detail can be explained as follows: Review of Interference and diffraction, funmental principles of Laser, waves Guide, holography, and non-linier. Optics.
General Objectives:	:	At the end of course you should be able to describe optical concepts using modern theory and its applications
Prerequisite Course	:	PAF 214 (Modern Physics)

No.	Special Objectives	Topics	Sub Topics	Time (menits)	Learning experience / methode	References
1	2	3	4	5	6	7
1	At the end of course you should be able to describe interference concepts and diffraction	Interference and Diffraction	1. Double and multiple slit Interference 2. Single and multiple slit diffraction	1x150	Lecture, discussion, homeworks	[1]: [3]:
2	At the end of course you should be able 1. Distinguish laser light and light 2. Calculate atom and/or molecule transition speed 3. Calculate energy result of atom and/ or molecule transition.	LASER	1. fundamental principles of laser 2. laser Transition scheme 3. Resonator 4. Properties of laser ray 5. Laser types	2X150	Lecture, discussion, homeworks	[2]
3	At the end of course you should be able waves guide concepts, properties, and *kegunannya.*	Waves guide		2X150		[2]
4	At the end of course you should be able to • Understand and describe the concept of holography and also its difference to	Holography	1. Introductory concepts of Holography	2X150	Lecture, discussion, homeworks	[1] [2]

No.	Special Objectives	Topics	Sub Topics	Time (menits)	Learning experience / methode	References
1	2	3	4	5	6	7
	conventional photography • Differentiate and describe the difference between transmission Hologram to reflection • Describe analytically quantitative the forming of shadow which perceived by observer • Design the simply hologram • Describe some usefulness of holography		2. Transmission and Reflection Hologram 3. Application of Holography			
5	At the end of course you should be able to • Understand and Describe the difference concept between linear optics to nonlinear • Understand and Describe the non-linier medium • Describe the concept of SHG, Pockel effect, Kerr Effect, Faraday Effect • Design Simple Experiment one of its Application	Introduction of Nonlinear Optics	1. Linier vs non linier optics 2. Nonlinier Medium 3. *Second harmonic generation* (shg) 4. pockel Effect 5. kerr effect 6. faraday effect 7. Acoustoosoptics effect 8. *Nonlinear optical phase conjugation*	2X150	Lecture, discussion, homeworks	[1]
7		Thin Layer Optics		2X150	Lecture, discussion, homeworks	

References:

[1]. Pedrotti, Introduction to Optics
[2]. Smith, Laser and Optical Communcation
[3]. Hecht, Optics
[4]. Jenkins and White, Optics

No.	Special Objectives	Topics	Sub Topics	Time (menits)	Learning experience / methode	References
1	2	3	4	5	6	7
			3. Moving Media 4. Inductance			
12.	At the end of course you should be able to describe Magnetic Energy	Magnetic Energy	1. Energy of a system of free current 2. Energy in terms of the magnetic induction 3. Magnet forces on circuits	2 x 50	Lecture, discussion, homeworks	2
13.	At the end of course you should be able to describe the magnetic multipole concepts	Magnetic Multipole	1. Multipole Expansion of the vector potential 2. Magnetic Dipole field 3. Filamentary currents 4. Energy of a current Distribution in external induction	2 x 50	Lecture, discussion, homeworks	2
14.	At the end of course you should be able to describe the Magnetization concepts	Magnetization	1. Concept and definition of magnetization 2. Magnetization current densities 3. **H** Field 4. Magnetic Materials 5. Energy 6. Magnetic Circuits	2 x 50	Lecture, discussion, homeworks	2
15.	At the end of course you should be able to re describe whole concept about elecric field and magnetic	Select capita	Repeating the concepts and definition of electrics field and magnetic	2 x 50	Lecture, discussion, homeworks	2
	Exam			100	Written exam	

Reference

1. Sciolla, G, *Electricity and Magnetism*, MITOpenCoursesware, 2007
2. Wangsness, R.K., 1986, *Electromagnetic Fields*, John Wiley & Sons, Inc, New York hal: 202-213

OUTLINES OF LEARNING PROGRAM

Course	:	**Experimental Physics II**
Course Code, credit	:	PAF 324 2 SKS/V
Description	:	These experiments demonstrate key aspects of physics covered in electronics, geophysics, nuclear physics, and materials physics lecture courses, as follow: plateau curve determination, Dead time determination, Counting statistics, Gamma Spectroscopy, x – rays diffraction, ESR, Geoelectrical (Sounding and Mapping), digital and analog Electronics
General Objectives:	:	At the end of course you should be able to use and be able describe to the instruments of experiments related to concepts in the electronics, geophysics, nuclear physics, and material physics
Prerequisite Course	:	PAF 311 (Fisika Nuklir), PAF 225 (Fisika zat padat)

No.	Special Objectives	Topics	Sub Topics	Time (minutes)	Learning experience / methode	References
1	2	3	4	5	6	7
1.	At the end of course you should be able to describe and to use the instruments of plateau curve determination	plateau curve determination ,		2x 50 minutes		
2.	At the end of course you should be able to describe and to use the instruments of Dead time determination	Dead time determination		2x 50 minutes		
3.	At the end of course you should be able to describe and to use instruments of Counting statistics	Counting statistics		2x 50 minutes		
4.	At the end of course you should be able to describe and to use the instruments Gamma Spectroscopy	Gamma Spectroscopy		2x 50 minutes		
5.	At the end of course you should be able to describe and to use the instruments of x – ray diffraction	x – ray diffraction		2x 50 minutes		
6.	At the end of course you should be able to describe and to use the instruments of ESR	ESR		2x 50 minutes		

7.	At the end of course you should be able to describe and to use Geoelectrical instruments (Sounding dan Mapping).	Geoelectrical (Sounding and Mapping).		2x 50 minutes		
8.	At the end of course you should be able to describe and to use the instruments of digital electronics	Digital Electronics		2x 50 minutes		
9.	At the end of course you should be able to describe and to use the Analog Electronics instruments	Analog electronics		2x 50 minutes		

References:

[1] Krane, K.S., 1983, *Modern Physics*, John Wiley & Sons
[2] Beiser, A., 1995, *Concepts of Modern Physics*, 5th Edition, McGraw-Hill, Inc., New York.

OUTLINES COURSE of SEISMOLOGY

Lecture : **Seismology**

Code/CSU : PAF 373/ 2

Brief description : This lecture contains the histrical developments and global topics of seismology, concepts of elasticity and seismic waves (stress-strain, equations of motion, wave equations, dispertion and oscillation and tsunami), wave interpretation (nomenclatures, determination of earthquake location), penentuan orientasi sesar dan seismic sources (proyeksi stereografik, mekanisme fokus, momen tensor serta energi dan megnitudo seismik)

General competence : Setelah mengikuti mata kuliah ini (pada akhir semester) mahasiswa dapat menjelaskan tentang konsep-konsep elastisitas dan gelombang seismik, dapat menginterpretasikan seismogram, dapat menentukan lokasi sumber gempa, dapat menghitung magnitudo gempa serta menyelesaikan masalah mekanisme sumber gempa.

prerequisites : PAF 215, 371,372

Nu	Special objectives	Topics	Subtopics	Duration (minutes)	Methods	References
1.	In the last session, the students will be able to explain the development of history and its related topics.	Histories of seismology	1. development of histories of global seismology 2. related topics in seismology	2x 50	Tutorial, discussions, assignments	[1] p 1-34 [2] p 1-13
2.	In the last session, the students will be able to explain the concepts of elaticity (*stress-strain*), equations of motion, wave equations, seismic wave and its characteristics	Elasticity and seismic wave	1. *Stress* 2. *Strain* 3. equations of motion 4. wave equations 5. body waves 6. surface waves 7. Dispertion dan polaritation 8. free oscillation 9. Tsunami	7x2x 50	Tutorial, discussions, assignments	[1] p 35-72 [2] p 61-88
3.	In the last session, the	Interpretasi	1. Nomenclatures of seismic	4x2x 50	Tutorial,	[1] p 203-237

	students will be able: to interpretate the seismogram, and to determine the locations of earthquake using methods of single station, many stations, and general inversion	seismogram	waves 2. time travel curves 3. Determination of locations of earthquake: single location, many stations, and general inversion		discussions, assignments	[2] p 95-98
4.	In the last session, the students will be able: to determine the sear orientations and seismic sources using stereographic projections of the solutions of sear surface, to determine the magnitude of earthquake waves using tensor moment and seismic energy.	Determination of sear orientations and the solutions of seismic sources.	1. stereographic projections 2. mechanism focals using surface waves 3. Seismic tensor moment 4. Scale of magnitude 5. seismic energy and seismic magnitude	4x2x 50	Tutorial, discussions, assignments	[1] p 313-387 [2] p 105-126

References :

[1]. Thorne Lay and Terry C. Wallace, 1995, *Modern Global Seismology*, Academic Press, San Diego

[2]. Bath, Markus, 1979, *Introduction to Seismology*, Birkhäuser Verlag, Stuttgart

[3]. Bolt, Bruce A., 2004, *Earthquake*, W.H. Freeman and Company, New York

OUTLINES COURSE of CRYSTALLOGRAPHY

Lecture : Physics of Crystallography
Code / CSU : PAF 392 / 2
Brief Descriptions : This course consists of concepts of basics behaviors of tensors in crystal.

General competence : after learn this course; the students will be able to use the concepts of basic behaviors of tensors in crystal and its applications.
Prerequisites : PAF 121, 214, 225

Nu	Special objectives	Topics	Subtopics	Duration (minutes)	Methods	References
1	2	3	4	5	6	7
1.	After this session, the students will be able to explain about crystals and symmetry of crystals.	Symmetry of Crystals	1. solid structure 2. crystal structure 3. 2-dimensional lattice 4. 3-dimensional lattice	2 x 50	speaking, discussion, problems solving practice	**[1]**, p. 1 - 8 **[2]**, p. 72 – 75
2.	After this session, the students will be able to explain about Indices of Miller	Indices of Miller	1. Indices of Miller 2. Bravais lattice 3. direction indices of crystallography 4. examples of symmetry of crystals	2 x 50	speaking, discussion, problems solving practice	**[1]**, p. 8 – 18 **[2]**, p. 73 – 93
3.	After this session, the students will be able to explain the introduction to tensors of crystal	Introduction to Tensors	1. Notation of tensors in crystals 2. reduction of tensor components 3. Transformation of axis 4. vectors transformations 5. *rank*-2 symmetric Tensor	4 x 50	speaking, discussion, problems solving practice	**[1]**, p. 19 – 35
1	2	3	4	5	6	7
4	After this session, the students will be able to explain the *rank*-2 Tensors and their applications	*rank*-2 Tensors	1. thermal conductivity and thermal resistance 2. heat flow in crystal samples 3. quadratic representations	2 x 50	speaking, discussion, problems solving practice	**[1]**, p. 36 - 49

			4. Diffusion			
5.	After this session, the students will be able to explain Electrical conductivity	Electrical conductivity	1. electrical conductivity in matter 2. electrical resistivity	2 x 50	speaking, discussion, problems solving practice	**[1]**, p.41 - 42 **[2]**,p.527 - 532
6.	After this session, the students will be able to explain *Rank*-4 tensors and elasticity	*Rank*-4 tensors and elasticity	1. *strain* 2. simetric and anti-simetric tensor 3. strain Tensor 4. *stress* 5. Elastisity 6. Notation of matrices	4 x 50	speaking, discussion, problems solving practice	**[1]**, p.50 – 70
7.	After this session, the students will be able to explain Optics of crystals	Optics of crystals	1. matrices equations 2. waves surface 3. biaxial crystals 4. double refraction on the boundary surface	4 x 50	speaking, discussion, problems solving practice	**[1]**, p. 71 - 87
8.	After this session, the students will be able to explain the axial tensors and their applications	axial tensors	1. Definition of axial tensors 2. vector transformation and axial tensors 3. optical rotary 4. Tensor of giration 5. Hall effect 6. miscelaneous applications of tensor	4 x 50	speaking, discussion, problems solving practice	**[1]**, p. 88 - 121

References:

[1] Lovett, D., 1989, *Tensor Properties of Crystals*, Institute of Physics Publishing, Bristol and Philadelphia.

[2] Shackelford, J.F., 1992, *Introduction to Materials Science for Engineers*, third edition, Macmillan Publishing Company, Inc.

OUTLINES COURSE of SELECTED TOPICS in MATERIAL PHYSICS

Lecture : **Selected Topics in Material Physics**

Code, SKS/Smt : PAF 396, 2/

Brief Descriptions : This course contains dielectric material, isolated electric material, and composite dielectric material.

General competence : After learn this lecture, the students will be able to identify, to classify, and to explain dielectric material.

Prerequisites : PAF 121, 214, 225, 391, 392, 301, 302, 303

Nu	Special objectives	Topics	Subtopics	Duration (minutes)	Methods	References
1	2	3	4	5	6	7
1	In the last session, the students in 5th semester will be able to explain and distinguish electrical and magnetic interactions in matter correctly.	1. electrical and magnetic interactions in matter	1.1. electrical interactions in matter 1.2. magnetic interactions in matter	2 x 50	tutorial, discussions, assignments	5, 6, 8, 11
2	In the last session, the students in 5th semester will be able to explain the microscopic structure material and to illustrate them correctly	2. the microscopic structure material	2.1. the microscopic structure substances 2.2. the Structure of chemistry and covalent bonding of dieiectric material 2.3. polar and non polar dielectrics	2 x 50	tutorial, discussions, assignments	5, 10
3	In the last session, the students in 5th semester will be able to explain and calculate displacement current and dielectric breakdown in certain	3. electric characteristics of dielectric material	3.1. Displacement current 3.2. Dielectric Breakdown 3.3. dielectric power and isolated integrations	2 x 50	tutorial, discussions, assignments	1, 3, 5, 11

Nu	Special objectives	Topics	Subtopics	Duration (minutes)	Methods	References
1	2	3	4	5	6	7
	material correctly					
4.	In the last session, the students in 5th semester will be able to explain and distinguish dielectric polarization in matter correctly.	4. dielectric polarization material	4.1. physical characteristics of dielectric polarization 4.2. dielectric polarization in gas 4.3. dielectric polarization in liquids 4.4. Polarization in *Lossy Dielectric*	4 x 50	tutorial, discussions, assignments	5, 6, 7, 11
5.	In the last session, the students in 5th semester will be able: 1.to describe and to express macroscopic considerations in material 1.to calculate the dielectric response correctly 2.to interpret the geometric process of relaxation, dielectric power, and isolated integration	5. Macroskopic material	5.1. dielectric response on relaxation process 5.2. dielectric disperse 5.3. relaxation and resonance 5.4. dielectric response on time domains 5.5. geometrical representation of dielectric relaxation process 5.6. relaxation process of double layers	8 x 50	tutorial, discussions, assignments	3, 4, 5, 6, 11
6.	In the last session, the students in 5th semester will be able to describe and to illustrate phase of dielectric material including the interpretation scheme	6. material phase	6.1. solid Dielectrics 6.2. liquid Dielectrics 6.3. gaseous dielectrics	4 x 50		**1, 2, 5, 8, 10**
7.	In the last session, the students in 5th semester will be able to explain and to identify isolated electric material.	7. isolated electric material	7.1. characteristics of dielectric isolators 7.2. characteristics of electrical *bulk* 7.3. solid isolated material 7.4. liquid isolated material 7.5 gaseous isolated material 7.6. composite isolators 7.7. anorganic isolators	4 x 50		**5, 9, 10, 11**
8.	In the last session, the students in 5th semester will be able to explain and identify composite	8. composite dielectric material	8.1. the theory of dielectric compounds 8.2. heterogeneous compound	4 x 50		

Nu	Special objectives	Topics	Subtopics	Duration (minutes)	Methods	References
1	2	3	4	5	6	7
	dielectric material.		permittivity 8.3. the dependence of permittivity on particular geometry 8.4. Textures of compounds 8.5. inter particular interaction in composite dielectrics			
9.	In the last session, the students in 5th semester will be able to explain and to calculate complex permittivity of composite dielectric material.	9. complex permittivity of composite dielectric material	9.1. description of symbols and notation 9.2. multiphase composite dielectric material	2 x 50		

Referensi:

[1] Richard L. Liboff, 1992, *Introductory Quantum Mechanics*, second edition, Addison-Wesley Publishing Company.
[2] C. Cohen Tanoudji, Bernard Diu and Frank Laloe, 1977, *Quantum Mechanics*, second edition, Jhon Wiley and Sons.
[3] Youv Peleg, Reuven Pnini and Elyahu Zaakur. 1998, *Quantum Mechanics*, Schaum out lines McGraw-Hill