ETHIRAJ COLLEGE FOR WOMEN

(AUTONOMOUS)

CHENNAI - 600 008

DEPARTMENT OF PHYSICS

Revised Syllabus for

M.Phil PHYSICS

(For students admitted from the academic year 2018 – 2019)

Ethiraj College for Women (Autonomous), Chennai – 600 008

Department of Physics

Master of Philosophy in Physics

(Revised syllabus effective from the academic year 2018 – 2019)

The duration of the course for full time is one academic year and every academic year is divided into two semester sessions. The duration of the course for part time is two years. Teaching is organized into a modular pattern of credit courses. Credit is normally related to the number of hours a teacher teaches a particular subject. It is also related to the number of hours a student spends learning a subject and carrying out a project.

Regulations

1. **Eligibility for Admission:**

Candidates for admission to the Degree of Master of Philosophy in Physics course should have passed two year M.Sc. degree course in Physics after three year degree course in Physics and Higher Secondary of twelve years duration or Pre-University under eleven year S.S.L.C + one year or 10+2 pattern. The minimum eligibility mark shall be as prescribed in the guidelines for admission to the M.Phil. degree in Physics by the University of Madras.

2. **Eligibility for the Award of Degree:**

A candidate shall be eligible for the award of the Degree only if she has undergone the prescribed course of study for a period of not less than one academic year (for full time and two academic years for part time), passed all the examinations as prescribed and earned a total of 36 credits.

3. **Course of Study:**

The main subject of study for M.Phil. Degree in Physics shall consist of the following

Core papers : 2

Elective paper : 1

Dissertation : 1

4. **Passing Minimum:**

A Candidate shall be declared to have passed in each paper / project of the Core subject of study wherever prescribed, if she secured NOT LESS THAN 50% of the marks prescribed for the end semester examination and there is no passing minimum for Continuous Assessment (CA).

5. **Classification of Successful Candidates:**

Successful candidates passing the examination and securing the marks

i) 60% and above and

ii) 50% and above but below 60% in the aggregate shall be declared to have passed the examination in the FIRST CLASS and SECOND CLASS respectively.

Candidates who pass all the examinations prescribed for the course in the FIRST APPEARANCE ITSELF ALONE are eligible for ranking.

6. **Question Paper Pattern:**

Unless and otherwise specified in the syllabus for each paper, the pattern of question paper shall be as follows.

Core and Elective Course:

Component	**Nature of the Question**	**Maximum Marks**
One	Descriptions / Application / Analysis / Synthesis	100

The paper can have 5 questions to be answered out of 8 questions covering the 5 units.

M.Phil. Physics

1.**Objectives of the Course**:

(i) The syllabus of the M.Phil course is designed in such a way that the student would have a thorough knowledge on the advancements in Physics and also expose herself to research.

(ii) To enable the students to acquire teaching skills, to plan the experimental projects and execute them.

(iii)After completion of the course with an M.Phil degree in Physics she can have a career in the following areas.

(a) Take up a teaching job at a college for science and engineering courses.

(b) Take up a job in a scientific laboratory and R&D institution.

(c) Pursue a research career in an academic institution or a National Institute/Laboratory.

2.**Course Profile:**

Course	**Course Content**	**Credits**	**Course Code**
1	Research Methodology	5	14M18/RMY
2	Materials Science	5	14M18/MLS
3	Elective – Internal Paper	5	14M18/EIP1, EIP2, EIP3
4	Dissertation	21	14M18/DTN
		Total:	**36**

3.**Evaluation Pattern:**

Theory

CA				End Sem. Marks	Total
Component	No.	Marks	Total		
Assignment	1	10	40	100 Reduced to **60** Marks	**100**
Seminar	1	10			
Test (50 Marks; 2 Hrs.)	2	20			

- End Semester Examination question papers for core is to be set by the External Examiner and evaluated by both Internal and External Examiners.
- Elective question paper is set and evaluated by Internal Examiner (Guide).
- Duration of examination is 3 hours.
- Maximum Marks is 100.

Dissertation & Viva-Voce:

* Continuous Assessment Marks : 50

** End Semester Examination Marks: 150

Total Marks : 200

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Continuous Assessment	Marks
Project work and presentation (Guide)	40
Viva-Voce (Guide)	10
Total	50

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End Semester Examination	Marks
Final Report and presentation (Guide and External)	100
Viva-Voce (Guide and External)	50
Total	150

RESEARCH METHODOLOGY

Core – 1 **Course Code: 14M18/RMY**
Credits: 5

Objectives:

- To equip the students with necessary research techniques required for the preparation of technical research papers.
- To give the students a firm grounding in mathematical and Numerical methods needed in research and advanced papers in Physics.

Course Outline:

Unit I: Techniques for Research

Nature and importance of research – aims, objectives, principles and problems – Identification of the problem – literature survey – reference – awareness of current status of the art, abstraction of research paper.

Unit II: Thesis Writing

Preparation of technical papers and thesis writing – presentation of data – symbols – the observations – tables and figures – equations – the style – sentence length – word length – page and chapter format – use of quotation and foot notes – referencing – appendices – reversing, editing and evaluating the final material – proof reading.

Unit III: Statistical Methods

Discrete and continuous random variables – Mean, variance, standard deviation, moments, Poisson, Binomial and normal distributions and their properties-skewness.

Elementary aspects of hypothesis testing: Simple hypothesis type I and type II errors; one tailed and two tailed tests, X^2 goodness–of-fits test – distribution.

Unit IV: Numerical Methods

Principle of least squares – straight line and parabola. Numerical differentiation and integration – Trapezoidal rule – Simpson's rule – Gaussian quadrature formula – Numerical solution of ordinary differential equations solutions by Taylor's series – Euler's method – Runge kutta method with Runge's co-efficient - Numerical solution of partial differential equations using finite difference method.

Unit V: Computer Programming and Internet

Review of C language – Application of C language – Matrix addition, Numerical Integration by Trapezoidal rule and Simpson's rule, least squares line calculation, calculation of mean and standard deviation of one dimensional random variables. Internet and its applications – e-resources to research – WWW – Web browsing.

Books Recommended Text Books for Study and Reference:

1. Rajammal PA Devadas , A hand book of Methodology of Research , 4th Edition, Vidhyalaya press, Coimbatore , 1976.
2. C.Hawkins and M.Sorgi, Research – How to plan, speak and write about it, 1st Edition, Narosa Publications 1987.
3. Satyaprakash, Mathematical Physics, 4th Edition, Sultan and Chand, 2002.
4. Terry E.Shoup, Applied Numerical methods for the Micro computer, 2nd Edition, Prentice Hall Inc., Englewood Cliffs, New Jeney, 1984.
5. Evous, D.J, Software for Numerical Methods, 2nd Edition, Academic Press Inc., New York, 1974.
6. E.V.Krishnamurthy, Numerical Analysis and algorithm, 4th Edition, Wiley Eastern, 1982.
7. Jain,M.K., Numerical Analysis for Scientists and Engineers, 2nd Edition, SBW Publishers, Delhi, 1971.
8. E.Balaguruswami, Programming in ANSI C, 3rd Edition, Tata McGraw-Hill Pub. Com Ltd., New Delhi 1988.

Online Sources:

1.http://www.slideworld.org/pdf-ebook.aspx/research%20methodology
2.http://www.sst.ph.ic.ac.uk/angus/Lecturs/compphys/comphys.html

Question Paper Template

Max. Marks: 100 **Time: 3 Hrs.**

Answer any FIVE the Questions: (5 x 20 = 100 Marks)

- 1 – 8 questions
- All questions carry equal marks
- Descriptive/Derivation /Programs type questions
- 5 questions to be answered out of 8 questions, covering all the 5 units

MATERIALS SCIENCE

Core – 2 **Course Code: 14M18/MLS**
Credits: 5

Objectives:

- To instill in the students the significance of solid state materials and their applications in various fields.

Course Outline:

Unit I: Nano Materials

Nanomaterials – Fundamentals Physics and chemistry of Nano-synthesis, physical and chemical methods – properties, chemical, mechanical - low temperature, high temperature –applications.

Unit II: Shape Memory Alloys and Bio Materials

Shape Memory alloys (SMA) – Characteristic properties, principle of Shape Memory effect, hystersis, two way SMA, super-elasticity, thermo-mechanical behavior - Processing –resistivity measurements, transformation of Shape Memory alloy with temperature, tensile strength– applications

Biomaterials – Classifications of biomaterials – Polymers, Mechanism and degree of polymerizations – Ceramics, Fabrication and Processing -Types –structure and optical properties and applications of Ceramics – Structure properties of polymers.

Unit III: Nonlinear Optical materials

Nonlinear materials – Principle – Classification, passive and active –Properties, polarization, frequency doubling or tripling, optical mixing, optical phase conjugation, optical rectification, phase matching-Nonlinear Materials, ADP, KDP, Lithium Niobate –applications.

Unit IV: Electrical, Optical and Semi-conducting Properties

Electrical conduction- band structure in solids - conduction in terms of band and atomic bonding models – applications - Insulators – Dielectrics - optical properties of metals and nonmetals - interaction of light with solid – applications of optical materials –Types of semiconductors, Extrinsic, Intrinsic - applications – Micro electrical mechanical systems(MEMS), Quantum dots, Spintronics.

UNIT IV: Characterization Techniques

Non destructive testing (NDT) techniques - X ray Diffraction (XRD) and FTIR as identity tools-Surface electron microscopy for analysis of surface morphologies - Ultrasonics – study of molecular interaction of materials – Atomic force microscopy – Determination of NLO efficiency of materials – Hardness studies - Polymer characterization – Thermo Gravimetric analysis – TDA and DSC.

Recommended Text Books for Study and Reference:

1. V. Rajendran and A. Marikani, Material Science, Tata McGraw Hill, New Delhi, 2nd Edition, 2005.
2. Leonid V. Azaloff, Introduction to Solids, 1st Edition, Tata McGraw Hill Publishing Company 2000.
3. C. Kittel Wiley, Introduction to Solid State Physics, 2nd Edition, Eastern University Edition. 1987.
4. S.L.Kakani and Amit Kakani, Material Science, 2nd Edition, New Age International Publisher, New Delhi, 2004.
5. C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson, Encyclopedia of Materials Characterization, 2nd Edition, Butterworth-Heinemann Publishers 1992.
6. C. N. Banwell, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata Mc Graw Publ 1978.
7. T. Jeyakumar, Baldevraj, V.Rajendran and P.Palanichamy, Science and Technology of Ultrasonics, 1st Edition, Narosa Publishing House, New Delhi, 2004.

Online Sources:

1. http://www.physics.brocku.ca/courses/4p70/
2. http://web.mit.edu./afs/athena/course/6/6/732/www/texts.html
3. http://wwwthphys.physics.ox.ac.uk/people/SteveSimon/condmat2012/LectureNotes2012.pdf
4. http://folk.uio.no/yurig/fys448/f448pdf.pdf

Question Paper Template

Max. Marks: 100 **Time: 3 Hrs.**

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- 5 questions to be answered out of 8 questions, covering all the 5 units

CRYSTAL GROWTH AND CHARACTERIZATION

Elective – 1 **Course Code: 14M18/EIP1**
Credits: 5

Objectives:

- To introduce the students to the various techniques of crystal growth and their characterization methods.

Course Outline:

Unit II Introduction to Crystals

Introduction to crystal symmetry and physical properties, point and space group, crystal binding - formation of solids – types of bonding – cohesive energy Vander Waal forces – Madelung energy.

Unit II Background of Growth technique

Growth techniques - criteria for equilibria in crystal growth - phase diagrams - solid solubility - classification of growth processes - kinetics of growth - nucleation, diffusion and surface migration - solution growth technique – low temperature, high temperature and gel growth.

Unit III Method of Crystal Growth

Bulk crystal growth methods - Kryopolous, Bridgman – Stockbarger - Growth of III-V and II-VI compounds - high pressure techniques - flame fusion and hydrothermal growth - chemical vapour deposition - hot wall epitaxy, molecular beam epitaxy, liquid and vapour phase epitaxy - MOCVD.

Unit IV Defects of Crystals

Surface impurity contamination - dopant solubility - defects - motion of dislocation, dislocation density and its determination - etch pit density - thermo dynamics of point defects - influence of defects on physical properties - conductivity, diffusion - application of defect in solid state.

Unit V Characterization Techniques

X-ray diffraction – basic principles – characterization by XRD – FTIR – methodologies and accessories – spectral analysis - Scanning electron microscopy – primary modes of operation – sample requirements – applications – Transmission electron microscopy –TEM operation – specimen preparation – Vicker's hardness tests – analysis of hardness parameters.

Recommended Text Books for Study and Reference:

1. Boardman A. D., O'Conner D. E. and Young D. A., Symmetry and its Applications in Science, London McGraw Hill, 1973.
2. Introduction to Crystallography Philips ELBS Publication.
3. B. D. Cullity Addison, Elements of X-ray diffraction, Wesley Publishers, 1977.
4. Santhana Raghavan and Dr. P. Ramasamy, Crystal growth processes and methods, KRU publications.
5. Leonid V. Azaloff, Introduction to Solids, Tata McGraw Hill Publishing Company.
6. C. Kittel Wiley, Introduction to Solid State Physics, Eastern University Edition.
7. C.Richard Brundle, Charles A. Evans Jr., Shaun Wilson, Encyclopedia of Materials Characterization, Butterworth-Heinemann Publishers, 1992.
8. Nakamoto K. Translated by Huang D.R. and Wang R.Q., Infrared and Raman spectra of inorgqanic and coordination compounds, 3rd Edition, Wiley, Beijing, Chemical Industry Press, (in Chinese), (1986).
9. C. N. Banwell, Fundamentals of Molecular Spectroscopy, Tata Mc Graw Publ.
10. V. Raghavan, Materials Science and Engineering, Fifth edition, PHI Learning, 2004.

Article:

1. Onitisch E.M, The present Status of testing hardness of materials, microscopie, Vol. 95, pp. 12 - 14. 1956.

Online Sources:

1.http://www.sciencedirect.com/science/book/9780444633033
2.http://cosmobillebooks.metroblog.com/download_ebook_crystal_growth_processes_based_on_capillarity_czochralski,_floating_zone,_shaping_and_crucible_techniques
3.http://www.hans-scheel.ch/downloads.html

Question Paper Template

Max. Marks: 100 **Time: 3 Hrs.**

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- 1 – 8 questions
- All questions carry equal marks
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- 5 questions to be answered out of 8 questions, covering all the 5 units

X- RAY CRYSTALLOGRAPHY

Elective – 2 **Course Code: 14M18/EIP2**
Credits: 5

Objectives:

- To introduce the students to the fundamental concepts behind structure determination using X-ray crystallography
- To equip the students with basic ideas on the geometries and symmetries of crystals
- To help the students grasp the concept of conformational analyses

Course Outline:

Unit I: Introduction

Description of lattices – lattice planes - Concepts of point groups - Space groups – symmetries – translations-rotations – inversion – screw glide – symmetry relationships –equivalent positions.

Fourier transforms – Real & Fourier space – Mathematical description of diffraction pattern using Fourier transforms

Unit II: Methods of Structure Analysis

Atomic Scattering factor-structure factor – electron density function –Friedels' law-systematic absences - Phase problem in crystallography –Methods of its solution(qualitative) – Patterson – Heavy atom – Anomalous scattering – Isomorphous replacement – Intensity measurement & data corrections

Unit III: Direct Methods

Unitary and normalized structure factors- Harker – Kasper inequalities – Sayer's relations – general phase and probability relations – structure invariants and semi invariants – symbolic addition methods

Unit IV: Experimental techniques & Refinement

X-ray sources – crystal setting – Powder method - Single crystal X-ray diffractometry Necessity for refinement- Trial structure – Cyclic Fourier refinement-Residual Index – Least square refinement

Unit V: Interpretation of Results

Bond lengths – Bond angles – Torsion angles – stereochemistry – concepts of conformation - Vander Waals radii of atoms – Vander Waal's interactions – hydrogen bonds – molecular stability – crystal packing.

Recommended Text Books for Study and Reference:

1. Dennis Sherwood , Crystal, X-ray and Proteins , Longman group Ltd, London
2. D. Velmurugan, Elementary Crystallography, MJP Publishers, Chennai
3. Stout and Jensen, X-ray Structure Determination, 2nd Edition, John Wiley Publications.
4. Ladd and Palmer , Structure Determination by X-ray Crystallography , 2nd Edition-Plenum Press, London
5. F.C.Philips, An Introduction to Crystallography, Longmans I Pbln.
6. M.M.Woolfson, An Introduction to Crystallography, Cambridge university press II Edn
7. W.Clegg, A.J.Blake, R.O.Gould, P.Main, Crystal Structure Analysis – Principles and Practice, Oxford university press.
8. Jenny P.Glusker, Mitchell Lewis and Miriam Rossi, Crystal Structure Analysis for chemists and biological, Wiley, VCH Edn.
9. C.Giacovazzo, H.L.Monaco, D.Viterbo, F.Scordari, G.Gill, G.Zanotti and M.Catti, Fundamentals of Crystallography, Oxford University Press, New York.

Online Sources:

1. http://www.mic.ucla.edu/X-ray/tutorials.htm
2. http://ocw.mit.edu/courses/chemistry/5-069-crystal-structure-analysis-spring-2010/lecture-notes/
3. www.youtube.com/watch?v=oj4QJ-1lxgU

Question Paper Template

Max. Marks: 100 **Time: 3 Hrs.**

Answer any FIVE the Questions: (5 x 20 = 100 Marks)

- 1 – 8 questions
- All questions carry equal marks
- Descriptive/Derivation /Programs type questions
- 5 questions to be answered out of 8 questions, covering all the 5 units

APPLICATIONS OF MOLECULAR SPECTROSCOPY

Elective – 3 **Course Code: 14M18/EIP3**
Credits: 5

Objectives:

- To give the students the overall perspective of various spectroscopic techniques.
- To introduce students to various spectroscopic instrumentation technique for quantitative and qualitative analysis of a given compound

Course Outline:

Unit I: Microwave Spectroscopy and UV visible Spectroscopy

The nature of electronic excitations – Origin of UV band structure – principles of absorption spectroscopy – instrumentation – solvents – effect of conjuction – aromatic compounds – model compound status – instrumentation of radiation with rotating molecules – isotope effect in rotational spectra – Stark effect – Quadrapole hyperfine interaction – Microwave spectrometer.

Unit II: FTIR Spectroscopy

IR Absorption process – uses of FTIR spectrum-modes of stretching and bending-IR spectrometer-Dispersive IR Spectrometers-Fourier transform spectrometer-preparation of samples of FTIR spectroscopy-Examination of FTIR Spectroscopy-Analysis of spectra-Hydrocarbons-Alkanes, Alkenos-aromatic rings-Alcohols and phenols-nitro, sulphur and phosphorous compounds- applications.

Unit III: Raman Spectroscopy

Nature of Raman Effect – Instrumentation techniques-sources- sampling methods-CARS- Raman effect in molecular structure- Laser Raman spectroscopy in molecular structural confirmation of water and carbondioxide molecule- study of molecular vibrations – applications.

Unit IV: Nuclear Magnetic Resonance Spectroscopy

Nuclear magnetic moments – Nuclear magnetic spectrometer – Ethyl group – survey of typical NMR absorptions by the type of compound-alcohols, Amines, ketones- coupling constant symbols- mechanism of coupling-aromatic compounds-substitutional benzene rings.

Unit V: Advanced NMR Techniques

Pulse sequences-pulse widths, spins and magnetization vectors-Determining the number of attached hydrogen-COSY Technique-HETCOR Techniques-Magnetic Resonance Imaging –Double resonance – f NMR.

Recommended Text Books for Study and Reference:

1. Pavia Lampman Kriz, Introduction to Spectroscopy, Third Edition, Thomson Books Cole, 2006.
2. C.N.Banwell and E.M.Mccash, Fundamentals of Molecular Spectroscopy, 5th Edition TMH, NewDelhi, 2013.
3. Walker and Straughan, Spectroscopy, 4th Edition, Volumes I & II, Champman and Hall, 1976.
4. B. Patania, Spectroscopy, 2nd Edition, Campus Books International, 2002.

Online Sources:

1.http://www.freebookcentre.net/chemistry-books-download/Introduction-to-Spectroscopic-methods-%28PDF-70P%29.html
2.http://www.digitalbookindex.org/_search/search010chemspectroscopya.asp
3.http://www.freebookcentre.net/chemistry-books-download/Principles-of-Spectroscopy.html

Question Paper Template

Max. Marks: 100 **Time: 3 Hrs.**

Answer any FIVE the Questions: (5 x 20 = 100 Marks)

- 1 – 8 questions
- All questions carry equal marks
- Descriptive/Derivation /Programs type questions
- 5 questions to be answered out of 8 questions, covering all the 5 units

RESEARCH TRENDS IN NANO SCIENCE AND NANO TECHNOLOGY

Elective – 4 **Course Code: 14M18/EIP4**
Credits: 5

Objectives:

- To familiarize the students with basics of Nano structured material for higher education.

Course Outline:

Unit I: Fundamentals of Physics and chemistry - Nano

Introduction: Physical and chemical properties of nano. Necessity of characterization. Macroscopic properties: Optical. Electrical, dielectric, magnetic, mechanical (b) Microscopic properties – chemical structure, composition, surface characterization.

Unit II: Quantum background of Nanomaterials

Quantum mechanics and Quantum Confinement: Introduction to Quantum mechanics and Quantum confinement and application with reference to Quantum wells, Quantum wires, Quantum dots, Nano clusters and Nano crystals.

Unit III: Synthesis of Nanomaterials

Introduction to Synthesis of Nanomaterials: Types and strategies for synthesis of nanomaterials depending on end applications. Zero-Dimensional Nanostructures: Nanoparticles: Introduction, different strategies for synthesis of 0D nanomaterials and their technological applications. One-Dimensional Nanostructures: Nanorods and Nanowires: Introduction, different strategies for synthesis of 1D nanomaterials and their technological applications. Two-Dimensional Nanostructures: Thin Film: Introduction, different strategies for synthesis of 2D

Unit IV: Characterization Techniques

Probing bulk and nano-structure – XRD, TEM, HRTEM, Neutron scattering. Surface structure and topography – SEM, STM, LEED, AFM. Microstructure – UVVIS, Raman, FTIR,

Unit V: Application of Nanotechnology

Applications of Nanotechnology in various fields: Renewable energy, solar energy, fuel cells etc. Materials manufacturing and automobile industry, Biomedical science, medicine, diagnostics, etc. Computers, electronics and communication Analytical, Pharma and Environmental sciences Biosciences- (Nano Biosciences - Biotechnology), Sport sector, printing, optics, Agriculture, food, textile, cosmetics, Defense, Aerospace and Marine Nanotechnology.

Recommended Text Books for Study and Reference:

1. Charles P.Poole, Jr. and Frank J.Owens, Introduction to Nanotechnology, Wiley, 2003
2. G.M.Chow and K.E.Gonslaves Nanotechnology - Molecularly Designed Materials American chemical society
3. J.D.Plummer, M.D.Deal and P.B. Griffin, Silicon VLSI Technologies, Prentice Hall, 2000
4. K.P.Jain, Physics of semiconductor Nanostructures: 3rd Edition Narosa Publishers, New Delhi 1997
5. Vladimir V. Mitin, V.A. Kochelap, M.A.Stroscio, Introduction to Nanoelectronics, 2nd Edition , Cambridge University press, 2011.
6. Sujaul Chowdhury, Nanosructure Physics an Microelectronics, 2nd Edition, Narosa Publishing house, Newdelhi
7. H. Nejo, Nanostructures – Fabrication and Analysis, 1st Edition , Springer International, Berlin.

Online sources:

1. https://en.wikibooks.org/wiki/Nanotechnology

2. http://www.nanowerk.com/nanotechnology/periodicals/ebook_a.php

3. http://bookboon.com/en/nano-technology-ebook

Question Paper Template

Max. Marks: 100 **Time: 3 Hrs.**

Answer any FIVE the Questions: (5 x 20 = 100 Marks)

- 1 – 8 questions
- All questions carry equal marks
- Descriptive/Derivation /Programs type questions
- 5 questions to be answered out of 8 questions, covering all the 5 units

DISSERTATION

Core – 3 **Course Code: 14M18/DTN**
Credits: 21

Course Outline:

For Students to adventure into research field both in theory and experiment, the dissertation has been introduced in the second semester. Here the student will explore new developments from books and journals, collecting literature/data and write a dissertation based on her work and studies.