VISION

The Medical Physics course is planned in such a way that it is committed to being at the forefront of finding better diagnosis and treatments for cancer patients by way of superior clinical care and clinical trials coupled with cutting edge research in medical physics field, cancer biology and health services.

MISSION

The Mission of the medical physics program is to introduce advancement in the practice of principles of Physics for diagnosis and treatment of disease by educating students, on the concepts of radiological physics, medical imaging, radiation therapy and radiation safety aspects. The program aims to provide students with necessary foundation and confidence through rigorous teaching, hands on practice and mentored research.
I. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To teach the students about the methodologies followed to carry out research in various advanced fields of Applied Physics.
2. To train students in data acquisition using the state-of-the-art Photonics equipments and in various scientific data analytic techniques so that they can analyze their research data and interpret the results. This will be helpful in their research activities.
3. To train the students in understanding the concepts of Laser theory and its applications in medicine and industry.
4. To enrich the knowledge of the students in the aspects of radiation dosimetry, medical imaging and renewable energy in order to develop new materials & techniques for medical and energy applications.
5. To provide knowledge on Computational techniques to understand the properties of materials and the influence of atmosphere on human health and train the students to design novel materials for societal applications in the thrust areas.

II. PROGRAMME OUTCOMES (POs):

After one year of completing the M.Phil. Applied Physics course the students are expected to have the following attributes with the corresponding outcomes:

<table>
<thead>
<tr>
<th>PO#</th>
<th>Graduate Attribute</th>
<th>Programme Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Scientific knowledge</td>
<td>Will develop specialist knowledge and skills in the fields of Laser Physics, Radialogical Physics, Computational Physics, and Atmospheric Physics.</td>
</tr>
<tr>
<td>2.</td>
<td>Practical ability</td>
<td>Will have the ability to pursue research in their field of interest using various data analytics tools and experimental facilities.</td>
</tr>
<tr>
<td>3.</td>
<td>Knowledge transfer</td>
<td>Will be able to evaluate and implement new technologies and in translation of research into professional practice.</td>
</tr>
<tr>
<td>4.</td>
<td>Modern tool usage</td>
<td>Will be able to develop the skills to critically evaluate and optimize the performance of advanced laser, radiation physics equipments, computational packages and procedures.</td>
</tr>
<tr>
<td>5.</td>
<td>Environment and sustainability</td>
<td>Design their experiments with environment consciousness and sustainable development.</td>
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<tr>
<td>6.</td>
<td>Ethics</td>
<td>Practice ethical, responsible, reliable, and dependable behavior in all aspects of professional lives, and a commitment to the profession and society. They will be able to establish and maintain standard protocols of operation in dosimetry and their respective research fields.</td>
</tr>
<tr>
<td>7.</td>
<td>Individual and team work</td>
<td>Ability to become an advisor to a team of professionals including oncologists, radiologists, radiotherapists, technologists and biomedical engineers. Ability to carry out independent and group research activities and become a research supervisor.</td>
</tr>
<tr>
<td>8.</td>
<td>Communication</td>
<td>Proficiency in oral and written communication with focus on writing research papers, reports, proposals and thesis.</td>
</tr>
<tr>
<td>9.</td>
<td>Design/development of new materials</td>
<td>Students will be given opportunities to survey research literature and thereby identify current problems in their respective fields.</td>
</tr>
<tr>
<td>10.</td>
<td>Conceiving concepts for fabrication of prototypes</td>
<td>To develop the concepts with proof for the fabrication of new indigenous devices for disease discrimination.</td>
</tr>
<tr>
<td>11.</td>
<td>Project Management</td>
<td>Will be able to use problem solving abilities to analyze outputs, derive inferences and provide solutions to the research team and thereby manage a research team.</td>
</tr>
<tr>
<td>12.</td>
<td>Life-long learning</td>
<td>Will be able to gain and induce lifelong learning skills, attitudes for social and personal development.</td>
</tr>
</tbody>
</table>

### III. PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of the program the student will have following Program specific outcomes.

1. Will have the ability to perform research in the fields of radiation dosimetry, medi photonics, ultrasonics, computational condensed matter physics, and environmental effects of radiation.
2. Will have the ability to derive inference on thrust areas in their respective research areas, perform experiments and computations and analyze results using various data analytics tools.
3. Can pursue a broad range of research projects.
4. Can teach medical physics courses to graduate students/Post graduate Medical students and Medical Physics students / dosimetrists.
5. To gain employment in Research and Development labs of government and private sectors.
1. PEO / PO Mapping:

<table>
<thead>
<tr>
<th>PROGRAMME EDUCATIONAL OBJECTIVES</th>
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Mapping of Course Outcome and Programme Outcome

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<th>Semester 2</th>
<th>Course Name</th>
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### ANNA UNIVERSITY, CHENNAI
### UNIVERSITY DEPARTMENTS
### M. Phil. APPLIED PHYSICS
### REGULATIONS – 2019
### CHOICE BASED CREDIT SYSTEM
### CURRICULA AND SYLLABI
### SEMESTER I

<table>
<thead>
<tr>
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**TOTAL NO. OF CREDITS: 33**

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5
### Research Methodology Course (RMC)

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### Employability Enhancement Course

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<th>S. No.</th>
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### Program Electives Course (PEC)

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<th>Course Title</th>
<th>Category</th>
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(Note: Attested by the Director of the Institute.)
## SUMMARY

**M.PHIL. APPLIED PHYSICS**

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Credits per Semester</th>
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<td><strong>16</strong></td>
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</table>
OBJECTIVE

- To expose the students with theoretical aspects of laser theory and its applications.
- To provide knowledge on laser theory, resonators and switching theory
- To provide knowledge on gas & liquid lasers, solid state & semiconductor lasers and their applications.

UNIT I  LASER THEORY  12
Absorption - Spontaneous and stimulated emission - Einstein’s coefficients - threshold conditions for laser action - Line broadening, Mechanism - Lorentzian and Doppler line shapes - Small signal gain - Gain coefficient - gain saturation - Rate equations for 3 and 4 level systems.

UNIT II  RESONATORS AND SWITCHING THEORY  12
Resonant cavity - Fox and Li - Boyd and Gordon’s theory on resonators - modes - Spot size - Types of resonators - Mode selection - Q switching theory and technique - Mode locking theory and technique.

UNIT III  GAS AND LIQUID LASERS  12
He-Ne, Argon Ion, Carbon dioxide, Nitrogen - Metal vapour - Gas dynamics - Excimer - Free electron lasers - Dye lasers - organic dyes - Pulsed and CW dye lasers - Threshold conditions - Pumping configurations.

UNIT IV  SOLID STATE AND SEMICONDUCTOR LASERS  12

UNIT V  APPLICATIONS  12

TOTAL: 60 PERIODS

OUTCOME

Employ students with the basic knowledge about
- lasers for material characterization,
- Speckle interferometry and Holography
- Different types of gas and Liquid lasers
- Solid and semiconductor lasers and their types
- medical applications at their fundamental frequency and higher harmonic

TEXT BOOKS


REFERENCES

OBJECTIVES

- To expose the students in different methodologies of research
- To expertise the students in mathematical and advanced statistical methods.
- To familiarize the students in advanced computing tools such as neural network and fuzzy logic.
- To train the students to handle the graphical and simulation software.

UNIT I  RESEARCH METHODOLOGY  12


UNIT II  MATHEMATICAL ANALYSIS  12

Execution of the research - Observation and Collection of data - Methods of data collection – Sampling Methods- Data Processing and Analysis strategies - Hypothesis-testing - Generalization and Interpretation.-Sampling distributions - Characteristics of good estimators - Maximum Likelihood Estimation - Interval estimates for mean, variance and proportions. Type I and Type II errors - Tests based on Normal, t, \( \chi^2 \) and F distributions for testing of mean, variance and proportions. Method of Least Squares – Regression Techniques; Normal, Partial and Multiple Correlations.

UNIT III  ADVANCED STATISTICAL METHODS  12


UNIT IV  NEURAL NETWORK & FUZZY LOGIC  12


UNIT V  GRAPHICAL AND SIMULATION SOFTWARE  12


TOTAL: 60 PERIODS

OUTCOME

On completion of this course, the students will be able to

- Understand the methodology of research, hypothesis and plagiarism concepts.
- Know about how to execute research and understand mathematical analysis.
- Gain knowledge to apply advanced statistical methods in research.
- Get aware about advanced computing tools such as neural network and fuzzy logic.
- Handle the graphical and simulation software.
TEXT BOOKS

REFERENCES

MY5001 LASER IN MEDICINE L T P C
4 0 0 4

OBJECTIVE
• To provide knowledge on the basics of Laser
• To teach the students in detail about the Laser Tissue Interaction
• Designed to teach the photobiological effects and its applications in diagnosis and therapy.

UNIT I LASERS AND ITS BEAM CHARACTERISTICS 12

UNIT II LASER TISSUE INTERACTION MECHANISM 12
Interaction of Light with Molecule - Photophysical process - Photobiological Process - Optical Absorption and Scattering by biological systems - different types of interactions - Thermal -Photochemical (one photon and multiphoton) - Photo ablative Process-Electro Mechanical Effect

UNIT III OPTICAL DIAGNOSIS 12

UNIT IV SURGICAL APPLICATIONSOF LASERS 12
UNIT V  THERAPEUTIC APPLICATIONS LASERS AND HAZARDS


TOTAL: 60 PERIODS

OUTCOME
On completion, students will be able to use
- Different lasers of optoelectronic devices for different diagnostic and therapeutic applications.
- Identify Tissue optical properties
- Basic principle of Photodynamic Therapy
- Lasers in Ophthalmology, Dermatology, Dentistry, Cosmetic surgery
- Laser and Its Safety in Medicine

TEXTBOOKS

REFERENCES

MY5002  BIOMEDICAL OPTICAL SPECTROSCOPY

OBJECTIVE
- Designed to provide the knowledge for use of different laser spectroscopic methods in bioanalysis.
- To study about the propagation of Light in Turbid Media
- To learn about various optical sources and detectors

UNIT I  TISSUE OPTICS
Structure of cells and tissues – light-matter interaction: absorption, scattering, reflection, refraction, luminescence, interference, polarization; their physical models and mechanisms. Specific features of living tissues from the point of optics. Relations of scattering and absorption in tissues - different interaction of lasers with tissues – Thickness and optical properties of appropriate skin layers - Skin pigments (melanin, bilirubin, carotene, hemoglobin) and their spectra - Composition of blood. Spectral properties of erythrocytes, thrombocytes and bloodplasma Differences between oxygenated and deoxygenated hemoglobin absorption spectra.

UNIT II  LIGHT PROPOGATION IN TURBIDMEDIA
Models of light propagation in tissues and the parameters used absorption and scattering coefficients, anisotropy, penetration depth, transport parameters; their connection with diffuse reflectance (remission). Time-resolved remittance models. Modeling of anisotropy, isotropic and layered tissue structures. Experimental studies of light propagation in tissues; tissue phantoms in experiments
UNIT III  OPTOELECTRONIC DEVICES  12

UNIT IV  OPTICAL SPECTROSCOPY IN MEDICINE  12
Optical characteristics of biomolecules from the point of spectroscopy – principles of UV – Visible absorption – IR and FTIR absorption – Raman and Fluorescence spectroscopy – application with regard to characterization of biomolecules – blood oxygen, glucose measurements, monitoring drug concentration, cancer diagnosis.

UNIT V  OPTICAL IMAGING OF CELLS AND TISSUES  12

OUTCOME
• The student can able to design different laser spectrometers
• Students can able to understand about the devices used for spectroscopic analysis and imaging of cells and tissues.
• Students will learn about FTIR, Raman and Fluorescentce spectroscopy techniques
• Students will understand about Confocal and FRET imaging
• Will learn about the application of multiphoton techniques

TEXTBOOKS

REFERENCES

MY5003  MEDICAL ULTRASONICS

OBJECTIVE
• To learn the interaction mechanism and production methodology of ultrasound.
• To learn about the tissue interaction mechanism and scanning methods
• To study about the various applications of Ultrasound

UNIT I  ULTRASOUND PRODUCTION AND ITS CHARACTERISTICS  12
UNIT II SCANNING METHODS 12
A, B, M-mode, system design-real time scanning –dynamic focus, compound scanning- resolution-axial, lateral- factors affecting image quality. 3-D, 4-D Applications to Ophthalm – Obstetrics and Gynaecology.

UNIT III DOPPLER METHODS 12

UNIT IV APPLICATIONS OF ULTRASOUND 12
Cavitation – types of cavitation – commercial ultrasound contract agent – molecular imaging –cases of sonoporation-drug carriees – therapeutic gases – cell death – high intensity focus ultrasound

UNIT V DOSIMETRY, SAFETY AND BIO-EFFECTS 12
Intensity- exposure time – spatial power & pressure measurement – mechanism of possible ultrasound induced biological effects- dose reduction techniques.

TOTAL: 60 PERIODS

OUTCOME
Students will Gain knowledge about
- Ultrasound & its safety level and importance of optimum scanning methodology.
- A scan and B scan
- Double Doppler effect
- Various applications of Ultrasound in medicine
- Ultrasound dosimetry and its safety

REFERENCES

MY5004 MOLECULAR IMAGING TECHNIQUES

OBJECTIVES:
- To enrich the knowledge about microscopes.
- To educate the types of microscopes, their resolution, image contrast and depth of investigation.
- To study the basic principles of Microscopes.

UNIT I OPTICAL MICROSCOPY 12

UNIT II SCANNING ELECTRON MICROSCOPY 12
Basic design of the scanning electron microscopy – types of electron source - Modes of operation- Backscattered electrons – secondary electrons- typical forms of contrast- Resolution and contrast – enhancement – Specimen Preparation - applications of SEM.
UNIT III TRANSMISSION ELECTRON MICROSCOPY

UNIT IV ATOMIC FORCE MICROSCOPY
Basic concepts-Interaction force - AFM tip on nanometer scale structures- force curves, measurements and manipulations-feed back control-different modes of operation –contact, non contact and tapping mode-Imaging and manipulation of samples in air or liquid environments- Imaging soft samples. Scanning Force Microscopy-Shear force Microscopy-Lateral Force Microscopy-Magnetic Force microscopy.

UNIT V SCANNING TUNNELING MICROSCOPY
Principle- Instrumentation- importance of STM for nanostructures – surface and molecular manipulation using STM -3D map of electronic structure.

TOTAL: 60 PERIODS

OUTCOME:
- Can use various microscopes to characterize the materials to study the surface properties
- Can differentiate various microscopic techniques
- Will learn about the electron sources used in microscopy
- Will learn about the 3-D mapping
- Identify the dislocations of crystals using microscopy

REFERENCES

MY5005 PHYSICS OF ADVANCED RADIATION THERAPY

OBJECTIVES
- To provide knowledge based and practical skills training to support the implementation of advanced Radiotherapy techniques in India.
- To study about Modern Radiotherapy Techniques
- To study about Image guidance in Radiation therapy

UNIT I CONFORMAL RADIOTHERAPY WITH MULTI LEAF COLLIMATOR
MLC - different categories –commercial MLC systems — MLC acceptance testing, commissioning and safety assessment - Quality Assurance of MLCs - Leaf position detection – recent developments in MLC.
UNIT II INTENSITY MODULATION RADIATION THERAPY
IMRT – Different methods – physical optimization — Target and critical structure definitions for IMRT — Static MLC IMRT, Dynamic MLC IMRT—potential problems with IMRT— Commissioning and QA for IMRT treatment planning— patient specific quality assurance— IMRT delivery system quality assurance.

UNIT III IMAGE GUIDED RADIATION THERAPY
Imaging techniques for guidance in Radiation therapy – clinical procedures in employing imaging technologies – Methods to manage respiratory gating - Effect of motion on the total dose distribution – 4D computed tomography imaging and treatment planning - Gated Radiation Delivery- IGRT QA protocol.

UNIT IV VOLUMETRIC MODULATED ARC THERAPY

UNIT V PARTICLE BEAM THERAPY
Proton beam therapy- Physics of proton beams- Equipment for proton beam therapy- configurations of proton delivery systems- treatment planning in particle therapy- Heavy ion therapy-Carbon ion therapy-Neutron therapy-Boron Neutron Capture Therapy.

TOTAL: 60 PERIODS

OUTCOMES
• Can learn about MLC in conformal therapy
• Can practice Arc therapy
• Can learn about proton beam therapy
• Can practice IMRT and IGRT
• To practice, all aspects of clinical medical physics with safe, accurate and effective delivery of Radiotherapy treatment

REFERENCES
OBJECTIVES

- Designed to teach the students about the basic radiation physics
- To study about various radiation quantities and Units
- To study about instruments used to detect and measure radiation.

UNIT I  ATOMIC STRUCTURE  12
Structure of matter - Atomic structure- Building up the models- schematic description of the atomic structure - nucleus - peripheral electrons/shells- Binding energies in atoms and molecules - energy and matter - binding energies in atoms and molecules - perturbation of binding energies - excitation - ionization- nuclear forces and nuclear energy levels - Abundance of stable nuclei as a function of the number of protons and neutrons - influence of N/Z on stability.

UNIT II  NUCLEAR TRANSFORMATION  12
Quantification of Radioactivity - activity: quantity and unit - General properties of alpha, beta and gamma rays- Radioactive transformations associated with strong interactions- associated with the electrostatic force and associated with the weak interaction and artificial radioactivity - radioactive disintegration and decay - Laws of radioactivity - half life of a radioactive nuclide - specific activity - equilibrium with radioactive daughter products- laws of successive transformations - natural radioactive series.

UNIT III  INTERACTION OF RADIATION WITH MATTER  12

UNIT IV  RADIATION QUANTITIES AND UNITS  12
Measurement of Activity - cuire - Becquerel - decay constant - half life - relationship between half life and decay constant - exposure and absorbed dose - Roentgen - Gray - electron volt (eV) - Half value layer as an index of penetration of radiation - linear and mass attenuation coefficients - KERMA - CEMA - Radiation Protection and its units - linear energy transfer (LET) - stomping power.

UNIT V  PRINCIPLES OF RADIATION DETECTION AND DOSIMETERS  12
Introduction - Properties of dosimeters - theory of gas filled detector - Ionization chamber - proportional counter - GM counter - dead time and recovery time - quenching - scintillation detector- semiconductor detector - Radiogaphic and radiochromic - Thermoluminescent dosimeters (TLD) - optically stimulated dosimeters (OSLD) - Gel dosimetry.

TOTAL: 60 PERIODS

OUTCOMES

- Students will learn about the basics about atoms and its structure
- Students will be able to understand about radiation and their interaction with matter,
- Different types of radiation quantities with their units
- Students will be able to learn about the principles of radiation detectors
- Different types of Radiation detection system

REFERENCES

MY5007  STEREOTACTIC RADIOSURGERY AND STEROTACTIC RADIOTHERAPY  L  T  P  C
4 0 0 4

OBJECTIVES
• To provide the knowledge on principle of gamma knife and linac based Radiosurgery and Radiotherapy
• To study about the structure and function of brain
• To study about the QA of SRS and SRT

UNIT I  STEREOTACTIC RADIOSURGERY AND STEREOTACTIC RADIOTHERAPY  12

UNIT II  CLINICAL INDICATIONS  12
Structure and Functioning of the brain. Clinical implications and malformations - AV AOVM, glioma, meningioma, acoustic schwanoma, pituitary adenoma and others.

UNIT III  LINAC BASED RADIOSURGERY  12
Physical principles involved in the design of current linear Accelerators-Design and Characteristics - Modifications to the normal accelerators for Radiosurgery- MLC - Dosimetry of various collimators-3D calculation algorithms for non-coplanar fields-Quality assurance checks for radiosurgery-Image fusion in treatment planning and treatment evaluation.

UNIT IV  QUALITY ASSURANCE  12
Scope of Computers in Radiation Treatment planning-Factors to be incorporated in computational algorithms- Cost effectiveness of Treatment Planning System -Hardware and Software requirements Periodic software and hardware Q.A checks - Installation and Quality Acceptance of TPS and Linac accessories for Radiosurgery.

UNIT V  RADIOBIOLOGY OF SRS AND SRT  12
Physical and Biological factors affecting cell survival-tumor re-growth and normal tissue response-Non conventional fractionation scheme and their effect of re-oxygenation, repair redistribution in the cell cycle - High LET radiation therapy - TDF- LQ Model-Radiobiology of Radiosurgery - Radiobiology of fractionated Stereotactic Radiotherapy.

TOTAL: 60 PERIODS

OUTCOMES
• Will learn about the LINAC based and Gamma knife based SRS and SRT
• Will learn about the functioning of brain their implications and Malformations
• Gain knowledge about 4-R in radiotherapy
• Can practice dosimetry of LINAC and Gammaknife
• Can perform quality assurance in Linac and Gamma-knife and treat patient with respect of Radiobiological effect

REFERENCES

MY5008 THREE DIMENSIONAL CONFORMAL RADIOTHERAPY

OBJECTIVES
- To expose the students with basic concepts of conformal radiotherapy.
- To impart knowledge on three dimensional radiation therapy.
- To learn about treatment planning, treatment optimization, conformal therapy with multileaf collimators, treatment machine features for conformal therapy, imaging for conformal radiotherapy planning.

UNIT I 3D RADIATION THERAPY TREATMENT PLANNING
Conformal radiotherapy treatment planning- Registration of two image datasets for 3D treatment planning –Summary and the NCI study of 3D therapy planning – Stages of Treatment Planning Dosimetry-Beam data Acquisition, Dosimetry with special detectors, data analysis and Input into 3D planning system – Dose verification with Phantom measurements.

UNIT II TREATMENT OPTIMIZATION

UNIT III CONFORMAL THERAPY WITH MULTI LEAF COLLIMATORS

UNIT IV MACHINE FEATURES FOR CONFORMAL THERAPY
Machine for conformal therapy with different radioactive isotopes –Tracking Units- tracking LINAC with MLC and CT combination –Universal Wedge-Dynamic Wedge- Wedges with MLC’s-Linear Accelerators with asymmetric collimators –Two Dimensional tissue Compensators.

UNIT V IMAGING FOR CONFORMAL RADIOTHERAPY PLANNING

OUTCOMES
- Prepare 3D and IMRT treatment plans
- Analyze and discuss treatment plans for special cases
- Can identify to use various wedges for various treatment
- Quantify the 3D planning for various sites
- Can practice Imaging in Conformal therapy

TOTAL: 60 PERIODS

18
REFERENCES

MY5009 COMPUTATIONAL CONDENSED MATTER PHYSICS L T P C
4 0 0 4

OBJECTIVES
- To provide fundamental knowledge on different computational methods
- To give theoretical background on solids and their properties
- To give knowledge on properties of materials relevant for medical physics

UNIT I MANY ELECTRON SYSTEMS 12

UNIT II UNIFORM ELECTRON GAS 12

UNIT III DENSITY FUNCTIONAL THEORY 12

UNIT IV METHODS OF BAND STRUCTURE CALCULATION 12
The tight-binding method - Linear Combination of Atomic Orbitals - General features of tight-binding levels - Wannier functions - muffin-tin potentials - augmented plane wave method – Pseudopotential methods – Examples – Application of different methods – Advantage of each method.

UNIT V BAND CALCULATIONS FOR MEDICAL PHYSICS 12

TOTAL: 60 PERIODS
OUTCOMES
Upon completion of this course, the students will be able to:

- Understand the theoretical background of solids and their electronic band formation
- Appreciate different approximations in theories like density functional theory
- Appreciate different approximations in theories like density functional theory
- Get a fundamental understanding on the electronic and optical properties of materials
- Apply their understanding while handling dosimeters and imaging techniques.

REFERENCES

MY5010 SEMICONDUCTOR MATERIALS: THEORY AND PRACTICE

OBJECTIVES

- To provide fundamental understanding on physics of semiconductors
- To give theoretical background on solids and their properties
- To give knowledge on properties of materials relevant for medical physics

UNIT I CRYSTAL STRUCTURE AND BONDING
Crystalline solids - Crystal systems - Bravais lattices –Coordination number – Packing factors – Cubic, hexagonal, diamond structure, Sodium Chloride Structure – Miller Indices - Visualization of crystal types and lattice planes using Crystal structure plotting tools – Interplanar spacing – Directions. Types of bonding - Madelung constants – cohesive energy.

UNIT II FREE ELECTRON THEORY AND ENERGY BANDS
Drude theory – Wiedemann-Franz Law and Lorentz number –Quantum state and degeneracy – density of states - free electron statistics (Fermi-Dirac), Bloch’s theorem – Kronig-Penney model- Construction of Brillouin Zones-Effective mass of electron-nearly free electron model – Tight binding approximation - classification into metals, insulators and semiconductors – Plotting Electronic bands and density of states using simple band structure codes – Understanding their origin.

UNIT III PHYSICS OF SEMICONDUCTORS
UNIT IV  OPTICAL PROPERTIES  12

UNIT V  SPECTROSCOPY: THEORY AND EXPERIMENTS  12

TOTAL: 60 PERIODS

OUTCOMES
Upon completion of this course, the students will be able to:
• Understand the theoretical background of solids and their electronic band formation
• Appreciate different types of crystal structure, bonding, structure-property relationships
• Classify materials based their electronic band structure
• Obtain a fundamental understanding on the optical properties of materials
• Apply their understanding while handling dosimeters and imaging techniques.

REFERENCES

MY5011  PHYSICS OF THE ATMOSPHERE  L T P C
OBJECTIVES
• Gain knowledge about atmosphere, weather and climate
• Understand the physical concepts such as radiation, thermodynamics and motion evolved in the fluid system.
• Explore different measurement techniques used in atmosphere probing.
• Reveal the importance of General circulation models (GCMs) and how simulations of the atmospheric circulation and its characteristics are performed.

UNIT I  THE EARTH’S ATMOSPHERE  12
UNIT II  ATMOSPHERIC RADIATION  12

UNIT III  ATMOSPHERIC THERMODYNAMICS  12

UNIT IV  ATMOSPHERIC DYNAMICS  12

UNIT V  ATMOSPHERIC MEASUREMENTS AND NUMERICAL WEATHER PREDICTION  12
Surface and upper air measurements- balloons, GPS radiosonde; Ground based remote sensing observations: LIDARS, Ionosonde, Radars and Use of Radars in atmospheric and meteorological investigation - Introduction to Numerical Weather Prediction (NWP) - Physical parameterization - Initialization and Data Assimilation - Advanced assimilation methods.

TOTAL: 60 PERIODS

OUTCOMES
The students will able to
- Gain knowledge about the physics of the atmosphere, weather and climate
- Understand the physical concepts such as radiation, thermodynamics and motion evolved in the fluid system.
- The students can understand the wave generation in a fluid medium.
- Acquire different measurement techniques used in atmosphere probing.
- Understand the importance of numerical simulation in weather forecasting.

TEXTBOOKS
1. C. Donald Ahrens, Essentials of Meteorology- An invitation to the atmosphere, 6 edition, Cengage Learning, 2011

REFERENCES
OBJECTIVE
- This course provides a broad knowledge on the Physics of middle atmosphere
- To gain the knowledge about physical interaction between waves and winds.
- To understand the impact of interaction between waves and winds.
- To know the application of Radar Technology in atmospheric probing.

UNIT I  STRUCTURE AND COMPOSITION OF THE MIDDLE ATMOSPHERE  12

UNIT II  WAVE - MEAN FLOW INTERACTION  12
Introduction, Beta plane Approximation and Quasi geostrophic theory - Atmospheric waves and its classification - Atmospheric tides, Free traveling planetary waves, forced planetary waves, gravity waves and equatorial waves. Transformed Eulerian Mean equations - Generalized Eliassen Palm theorem - Charney Drazin non acceleration theorem

UNIT III  EXTRA-TROPICAL CIRCULATION AND SUDDEN STRatospheric WARMING  12
Models of the middle atmosphere - Inclusion of wave forcing effects - Winter Polar Stratosphere - Stratospheric Sudden warming (SSW) and its Types - Observed features of sudden warmings - Theoretical modeling of Sudden warmings: Matsuno’s model - wave - wave interaction. SSW in northern and southern hemisphere - Stratospheric Ozone depletion and Antarctic Ozone hole

UNIT IV  EQUATORIAL CIRCULATIONS AND TRACER TRANSPORT  12
Equatorial Quasi Biennial Oscillation (QBO) and its structure - Holton Lindzen theory of QBO - Semi Annual Oscillation and its structure - Transport Processes in the Stratosphere and Troposphere: QBO and Brewer Dobson Circulation, atmospheric waves and tracer transport, wave influence on mean circulation - Meridional circulation in Stratosphere and mesosphere

UNIT V  RADAR TECHNOLOGY IN MIDDLE ATMOSPHERE  12
Radar and its operating principle - Middle atmosphere radars: MST, MF or partial reflection, LF, Meteor Wind, and ST Radars - momentum flux studies - Tropospheric temperature measurements - Precipitation and humidity measurement using ST radar, Convection studies with MST radars, radar in mesospheric studies.

OUTCOME
On completion of this course, the students will be able to
- Gain information about the mechanics and dynamics in any fluid medium
- Gain knowledge about the structure and dynamics of middle atmosphere
- Understand the physical interaction between waves and winds.
- Know the impact of interaction between waves and winds.
- Understand the application of Radar Technology in atmospheric probing.
TEXTBOOKS

REFERENCES