University of Rajasthan
Jaipur

Syllabus for the New Course

M. Tech. Engineering Physics 2010-2012

Two years and four semesters Course of M.Tech. (Engineering Physics) suitable for BE, B. Tech. or M Sc (Physics) passed out candidates. The course will emphasize more on practical training of students so that student can undertake the challenging tasks related to the design and modeling of new equipments or new technologies, with special emphasis on Nuclear, Accelerator Solar and Microwave Technology. The course will be of four semesters of which final semester will be dedicated project work.

20 Seats

The method of examination will be continuous evaluation with internal tests (30%) and External Examination (70%)
The passing marks will be 50% and shall have credit based system.

1st Semester:

S.No.	Course Code	Title of the course	marks	hours
1.	MTEP-01	Introduction Nuclear Technology	100	60
2.	MTEP-02	Introduction to Electronic & Communication	100	60
3.	MTEP-03	Introduction Solar Energy and materials	100	60
4.	MTEP-04	Laboratory work -I	200	180

2nd Semester:

S.No.	Course Code	Title of the course	marks	hours
1.	MTEP-05	Nuclear Energy	100	60
2.	MTEP-06	Microwave Devices	100	60
3.	MTEP-07	Solar Photovoltaics	100	60
4.	MTEP-08	Laboratory work -II	200	180
		Summer Training		

3nd Semester:

S.No.	Course Code	Title of the course	marks	hours
1.	MTEP-09	Accelerator Technology	100	60
2.	MTEP-10	Microwave and optical communication	100	60
3.	MTEP-11	Solar Thermal Technology	100	60
4.	MTEP-12	Laboratory work -III	200	180
		Project Planning		

4rd Semester:

S.No.	Course Code	Title of the course	marks	hours
1.	MTEP-13	Project Development work & Presentation/Demonstration	500	360

MTEP-01 Introduction Nuclear Technology

Radioactivity and Interaction of Neutrons:
Radioactive nuclides and induced activity. Attenuation coefficient, stopping of radiation, Brehmsstrahlung intensity, (g, n) reaction, (n, alpha) reaction, neutron production reactions, evaporation, pre-equilibrium and spallation neutrons, radiative capture reaction, cold, slow, intermediate and fast neutrons. Interaction cross section and macroscopic cross section. Elastic and inelastic interaction of neutrons, Maxwell Boltzmann distribution, reaction rates. Variation of cross section with neutron energy.

Neutron Transport :
Diffusion Theory- One speed neutron conservation, neutron leakage, diffusion equation, coefficient and diffusion length, solution of diffusion equation, boundary conditions, diffusion eqn. in nonmultiplying media, case of point source and infinite plane source.

Radiation Damage:
Shielding design, attenuation calculations, reactor shield analysis-radiation transport in core and shield, experimental measurements, ducts and voids, shielding materials, radiation damage and measurements, strength of materials, creep, defects, corrosion, erosion, swelling.

Types of Accelerators: Van de Graph, Tandem, LINAC, Cyclotron, Synchrotron, LHC.
Application of Accelerators: Medicine, Radioactivity, Material Modification and Nuclear Energy.

References:

1. Samuel Glasstone and Alexander Sesonske, Nuclear Reactor Engineering vol. 1, Edition 4 (1998), CBS publishers and Distributors
2. Nuclear Reactor Physics, W.M.Stacey,John Wiley and Sons (2001)

MTEP-02 Introduction to Electronics and Communication:

Introduction to microwave communication, microwave frequency spectrum: advantages and applications, modes of propagation of EM waves in waveguides,
Microwave sources:
(i) Tube based: Klystron: Velocity modulation process, bunching process, output power and beam loading; Reflex Klystron: power output and efficiency; Traveling Wave Tubes; Magnetron, Gyratron etc.
(ii) Solid state devices: Gunn oscillator, IMPATT and TRAPATT Diode, Microwave Tunnel diode, YIG oscillator,
Microwave components: S-parameter analysis of the microwave circuits;

(i) Microwave passive components: Termination (Short circuit and matched terminations) Attenuator, phase changers, E&H plane Tees, Hybrid Junctions. Directional coupler.

(ii) Microwave active components: Microwave transistors, Microwave filters, Varacter Diode; Parametric amplifier: Manely Rowe relations, parametric upconvertor and Negative resistance parametric amplifier, use of circulator, Noise in parametric amplifiers; MESFET: Principle of operation, equivalent circuit, cut off frequency, power frequency limitations, MOSFET: Mechanism, modes of operation, transconductance, max operating frequency and microwave applications and HEMT structures: Structure, operation, characteristics, transconductance and cut off frequency, microwave applications

Optoelectronic devices: Semiconductor fundamentals, LED, LASER, Optical fiber, Photo detector
Microwave communication: Ionosphere, LOS and OTH communications

References:

1. Solid state Electronic Devices by B.G. Streetman and S. Banerjee, PHI
2. Foundations to microwave engineering by R.E. Collins, McGraw Hill
3. Microwave devices & circuits by S.Y. Liao, PHI
4. Solid State physical electronics by A.Vanderziel, (PHI, India).
5. Introduction to microwave theory by Atwater (McGraw Hill).
6. Microwave electronics by RE Soohoo (Addisen Westey public company)
7. Theory and application of microwaves by A.B. Brownwell & RE. Beam (McGraw Hill)
8. Optoelectronics and photonics: Principles and Practices by Safa O Kasap, Pearson,
9. Microwave Engineering Passive Circuits by P.A. Rizzi, PHI

MTEP-03 Introduction Solar Energy and Materials

Solar radiation, spectrum, UV, VIS, IR Solar constant, optical response of materials optical band gap semiconductors elemental, compounds and organic semiconductors.

Planner P.N. Junction. I-V curve of dark and illuminated junction. Solar cell parameters.

Solar cell fabrication techniques, solid state diffusion, chemical vapor deposition, spin coating screen printing. Lamination and encapsulation. (i) Technology Pathway Partnership(ii) University Photovoltaic Product & Process Development (iii) Photovoltaic Supply Chain & Cross- Cutting Technology.

Solar Thermal Converter Systems
Principal, materials and design development of heat transfer units in context to domestic community and commercial(large scale) solar thermal appliances.
Tracking Non tracking Solar concentrator, solar chimney, solar steam generators, solar ponds and solar still. Solar furnace. Solar Dryer.

Renewable Energy System Analysis and
Market Transformation for Solar Technologies

References:

1. Essentials of solar cells by N.P. Singh and Kotalana
2. Solar Energy - G.N. Tiwari, Narosa Publication

MTEP-04 Laboratory work:

Design and Development of Low Voltage High Voltage High Current Power Supplies.
Design and Development of Nuclear Electronic Circuits, Like: Preamplifier, Amplifier, Discriminators, Analyzers and Counters.
Design and Development of Control Systems.

MTEP-05 Nuclear Energy:

Slowing Down of neutron:
Elastic scattering, change in energy, empirical scattering law, Average logarithmic energy decrement, lethargy, neutron moderation with and without absorption, Resonance absorption in

heterogeneous system, thermalization, spatial distribution of slowed down neutrons, Fermi Age Model, Migration length, Two group critical equation, reflection and four factor formula.
Design and Principle of Reactor Operation Safety, Fuel Design and Manufacturing, Fuel Management and Operational Physics, Mechanical Equipment in Nuclear Power Production, Electrical and Instrumentation Equipment in NPP, Plant Dynamics and Control .

Nuclear Power Reactors and Safety issues
Pressurized Water Reactors , Boiling Water Reactors , Pressure Tube Heavy Water-Moderated Reactors, Pressure Tube Graphite-Moderated Reactors, Graphite Moderated Gas-Coolcd Reactors, Liquid-Metal Fast Breeder Reactors, Other Power Reactors , Characteristics of Power Reactors, Advanced Reactors , Modular Passively Safe Light Water Reactors , Mixed Oxide PWRs , Gas-Cooled Reactors , Fast Reactors, Criticality and Flux Distribution Calculations, Criticality Safety Analysis, Interaction of Reactor Physics and Reactor Thermal Hydraulics , Power Distribution , Temperature Reactivity Effects , Coupled Reactor Physics and Thermal-Hydraulics Calculations.

Nuclear Waste management
Radio-active Hazard, Radio-Toxicity, Short and Long lived nuclear waste, nuclear safety and proliferation, different methods of nuclear reposition, ongoing projects and plans spent fuel and extraction from the spent fuel, chemical and laser techniques,
Transmutation of different nuclear wastes using ADS concept. Possibility of re-application of spent fuel in ADS. Discussion of irradiated reactor steel reprocessing and safety standards.

Fast Breeder Reactor, Accelerator Driven Sub critical Reactor (ADS), Fusion Reactor

Reference:

1. W.M.Stacey, Nuclear Reactor Physics, John Wiley and Sons (2001)
2. H.F.Nifnecker, S David and O. Maplan, Accelerator Driven Subcritical Reactors, 2003, IOP.
3. Samuel Glasstone and Alexander Sesonske, Nuclear Reactor Engineering vol. 2, Edition 4 (1998), CBS publishers and Distributors
4. James J. Duderstadt and Louis J. Hamilton, Nuclear Reactor Analysis, John Wiley and Sons, 1942
5. Fundamentals of Nuclear Reactor Physics, E.E.Lewis, Acad. Press, 2008.

MTEP-06 Microwave Devices:

Microstrip transmission line: Types of transmission lines, Modes of propagation, Design equations, Characteristic impedance, attenuation in planar microstrip lines
Planar strip line devices: Design equations and characteristics of planar phase shifters, attenuators, filters, couplers and power dividers
Microstrip antennas and arrays: Rectangular and circular patch microstrip antennas: design equations, Calculations of antenna parameters, radiation patterns in different planes and polarization conditions, Microstrip arrays: Array factor, Linear and planer arrays, radiation patterns in different planes and conditions
Microwave propagation in ferrites, Faraday rotation, Devices employing Faraday rotation Ferrite based components: isolator, Gyrator, Circulator. Introduction to single crystal ferromagnetic resonators, YIG tuned solid state resonators, microwave absorbers.
Computational Electromagnetics: Introduction of analytical methods: Transmission line model, Cavity model, Cavity model based Modal expansion technique, FDTD model, Method of moment and Green's functions
Microwave instruments and measurements:

(i) Advanced Microwave instruments: Modern microwave measurement instruments: Scalar and Vector network analyzer, Spectrum analyzer, Power meter

(ii) Microwave measurements: Microwave Power and VSWR measurements, Use of Smith chart, Input impedance and Antenna measurements

EM simulators: Simulation of microstrip antennas and other microwave components

References:

1. Microstrip Antennas by Bahl & Bhartiya (Artech House, Messachausetts)
2. Antenna Theory Analysis by C.A. Balanis Harper & Row. Pub. & Inc. New York.
3. Introductions to Microwaves by G.J. Wheeler, Prentice Hall
4. Stripline-like transmission lines for microwave integrated circuits by Bharathi Bhat, Shiban K. Koul, New Age International (P) Ltd., New Delhi
5. Foundations to microwave engineering by R.E. Collins, McGraw Hill
6. Microwave Engineering by D.M. Pozar, Wiley India

MTEP-07 Solar Photovoltaic

Solar Photovoltaic: - Development of single silicon crystal solar cell. Increasing efficiency of silicon cell. Multi crystalline solar cells. Planner P-N junction. Thin films Amorphous- Silicon solar cell. Copper Indium Salenide Solar Cells. Cd-Te and Zns Solar Cells, Organic Solar Cells, Hetro junction Solar Cells, Die sensitized Solar Cells, Tendon Solar Cells, Buffer Layer Solar Cells.

Vacuum Techniques*:* Production and measurement of vacuum, different typesof vacuum systems and gauges, their working and limitations, leak detection, techniques for production of ultra high vacuum. The laboratory work will consist of experiments with a vacuum system and assembling of a vacuum system.

Fabrication Techniques for :

Sc solar cell, a-Si solar cells. Thin film CIGS solar cells organic Photovoltaic
solar cells. Solar concentrated Buffer Layer Tendam Solar Cell.

Refference:

K. L. Chopra, Thin Film Phenomena, Mcgraw Hill, 1968.
Jackie Ying, Nanostructured Materials, Academic Press, 2001.
M.Ohring, Materials science of Thin Films, Academic Press, 1992.
Surface Science, K.W. Kolasinski, John Wiley, 2002.
J.H. Fendler, Nanoparticles and Nanostructured Films, Springer, 2000.
D.L. Smith, Thin Film Deposition, Mcgraw Hill, 1995.
Quantum semiconductor Devices and Technologies, T.P. Purcell , Kulwer Academic Publishers, 2000.
A.Ulman, An introduction to Ultrathin Organic Films from Langmuir Blodgett to Self Assembly Academic Press, 1990.
C.P. Poole and F.J. Owens, Introduction to Nanotechnology, Wiley Interscience, 2003.

MTEP-08 Laboratory work and Industrial Visits.

VISIT to IUAC, New Delhi, BARC Mumbai, RRCAT, Indore, RAPP, Rawatbhata, Kota, VECC Kolkotta., NFC Hydrabad, IGCAR, kalpakkam, TN.

1) Brehmstrahlung using Co^{60}- source and NaI scintillator,
2) Computer program of Koch and Moss relation of (e,g) intensity,
3) Activation of gold and In and determination of n-flux
4) Determination of Fermi Age using Am-Be source
5) Leakage probability in Howitzer paraffin tank for 5 Ci Am-Be source
6) Simulation of neutron transport
7) Training of TRIM for low energy radiation
8) PAL experiments

9) HV power supply
10) Preparation of radiation resistant materials, ZrC etc.
11) Beta ray spectrometry of activated materials

MTEP-09 Accelerator Technology:

Ion Sources: Gaseous and solid ion sources, thermal and RF excitation, positive or negative ion, radioactive ion source, ECR source.

Acceleration: DC and RF Tandem acceleration Electron Accelerator, Storage rings (Electron and proton) Plasma (Wakefield) Acceleration

Beam dynamics ; Liouville's theorem, Concept of Emittance, Acceptance, Beam extraction, Beam Transport, Neutral beam injection, Mathematical codes.

Vacuum Technology: Paschen's law, Vacuum pumps: (roughing pump, dry pump, ion sublimation pump, TMP etc) ,Leak detection, Vacuum measuring devices etc

Accelerator based applications: Ion beam and PIXE particle induced X-ray emission techniques, applications in semiconductor technology, material analysis, Atomic Mass Spectroscopy AMS, environmental studies and medicine. Medical accelerator (Imaging and Therapy) ,Radio Active Ion beam (RIB), Isotope production

Cyclotron, Betatron and LINAC Synchrotron, APS (American Photon Source) pelletron, and LHC (Large Hydron Colloider) Radiation Therapy and Colloider

Reference:

Accelerator Based Research in Basic and Applied Sciences, 2002, Amit Roy and D K Avasthi, Phoenix Publishers

Accelerator Technology and Applications by Anil Jain

MTEP-10 Microwave and Optical communication:

Microwave communication:
Ground wave and space wave communication, transmitting and receiving antenna system, Satellite communication:
(i) Orbital mechanics and launching: Laws governing Satellite motion, Satellite Path, Geostationary satellites, Non geostationary Constellations, Launching of Satellites, Channels, transponders,
(ii) Satellite link design and analysis: Transmission equation, noise considerations, Link design.
(iii) Modulation and multiplexing techniques: System considerations, linear modulation scheme, frequency modulation and digital modulation.
(iv) Multiple Access techniques: FDMA, TDMA, CDMA & DAMA.
(v) Propagation effects: Rain and ice effects.
(vi) VSATs, DBS-TV, GPS, Concept of high altitude platform and special satellites.

Optical communication:
(i) Introduction to optical communication: Principles of light propagation in fibers, step index and graded index fibers, mono mode & multimode fibers; connectors, splices, bends.
(ii) Transmission Losses: Dispersion, attenuation & scattering in fibers, link analysis.
(iii) Fiber Measurement: Measurement of fiber attenuation, bandwidth, power, & cut-off wavelength, OTDR.

(iv) Multiplexing in fibers, Optical Networks & Components : WDM, DWDM, optical couplers, Mach-Zehnder interferometer multiplexer, optical add/drop multiplexers, isolators, circulators, optical filters, tunable sources and tunable filters, arrayed waveguide grating, diffraction grating,

(v) Optical switching, WDM networks. Fiber Amplifiers

References:

1. Electromagnetic waves & Radiating Systems: Jorden & Balmain, PHI.
2. Tri T. Ha. Digital Satellite Communication, Mc-Graw Hill International Ed.
3. Pratt, T. Bastian, C., Allnutt, J. Satellite Communications , John Wiley &sons.
4. Roddy, D. Satellite Communication, Mc-Graw Hill International Ed.
5. Richharia M., Satellite *Communication Systems .*
6. Fiber Optics and Optoelectronics – R.P. Khare
7. Optical Communication – Keiser
8. Optical fiber communication - J.M. Senior
9. Optical fibres & Fibre Optical Communication Systems - Subir Kumar Sarkar

MTEP 11- Solar Thermal Technology

Solar Radiation: Solar Radiation, Instruments for measuring solar radiation, Empirical equations, Solar radiation on tilted surfaces.

Liquid Flat Plate Collectors: Basic elements, Types of flat plate collectors, Performance analysis, Transmissivity - absorptivity, Heat transfer coefficients and correlations, Collector efficiency and heat removal factors, Effects of various parameters, Transient analysis.

Concentrating Collectors: Type of concentrating collectors, General characteristics and geometry, Heat transfer correlations, Tracking requirements, Performance analysis.
Solar Air Heaters: Type of air heaters, Performance analysis of a conventional air heater.

Thermal Energy Storage: Methods of Solar energy storage, Sensible heat storage – liquids – solids analysis, Latent heat storage, Thermo-chemical storage, working of solar ponds, Temperature distribution and collection efficiency, Performance analysis.
Solar Stills: Types of solar stills, Design aspects and Performance analysis
Solar Refrigeration: Adsorption and absorption based solar refrigeration technologies

References:

1. Krith F. and Krelder J.F., Principles of Solar Engineering**,** McGraw hill Book Company, 1978.
2. John A, Duffie, William A. Beckman; Solar Engineering of thermal processes, , John Wiley and Sons, 1991.
3. Garg H.P. and Prakash J., Solar energy fundamentals and application, TATA McGraw Hill Publishing Company limited, New Delhi, 2000
4. Sukhatme S.P., Solar Energy Principle of thermal collection and storage, TATA McGraw Hill Publishing Company limited, New Delhi, 1996

MTEP 12: Laboratory work and Seminar

Project Planing and Proposals discussions on :

Small unit MODEL, Instrument, Software, Sensor, Detector or Control system useful at any of the Centers Like:

IUAC, New Delhi, BARC Mumbai, RRCAT, Indore, RAPP, Rawatbhata, Kota, VECC Kolkotta., NFC Hyderabad, IGCAR, kalpakkam, TN.

MTEP 13: Project work and Dissertation (Full Semester IV)

Design and Development of working small unit MODEL, Instrument, Software, Sensor, Detector or Control system usful at any of the Centers Like:

IUAC, New Delhi, BARC Mumbai, RRCAT, Indore, RAPP, Rawatbhata, Kota, VECC Kolkotta., NFC Hydrabad, IGCAR, kalpakkam, TN.

The Examination Pattern:

The method of examination will be continuous evaluation with internal tests (30%) and External Examination (70%)
The passing marks will be 50% and shall have credit based system.

1. The theory papers will have five questions. Q1 will have 10 parts short questions covering full syllabus. Other Q2-Q5 will have internal choice, with 40% numerical parts.
2. The Practical Examination will be of five hours duration. A board of examiners will assess the performance, in each semester.
3. The Seminar will be evaluated by the board of examiners at the 4th Semister.

Admission Procedure:

The admission will be on the basis of Merit only this year 2010. Gate qualified candidate will be preferred on the basis of their score. However, admission for the next session will be on the basis of Admission test.

Faculty and Teaching:

The course will be on the basis of Self Financing Course (SFS). The teaching will be on the on the Guest Faculty based, on the honorarium as per new UGC norms (Rs 1000/- per lecture, with maxim of Rs 25000/- pm. A few experts faculties are available in the University and MNIT. Others will be Invited from BARC, IUAC TIFR and IPU, Delhi .

The laboratory will be run by CDPE staff, teaching and non teaching, with extra honorarium as per SFS norms in the university.