Bachelor of Science
B.Sc. Physics (Semester -VI)

Course Code	US06MAPHY01	**Title of the Course**	Quantum Mechanics
Total Credits of the Course	4	**Hours per Week**	4
Course Objectives:	1. To give basic and preliminary knowledge of quantum mechanics and its mathematical details of computing observable physical quantities through examples. 2. To train the students in the physical interpretations of the wave functions, their asymptotic behavior, the energy Eigen values and Eigen functions etc.		

Course Content		
Unit	**Description**	**Weightage (%)**
1.	**Stationary States and Energy Spectra** Stationary States: The time independent Schrödinger wave equation, A particle in a square well potential, Bound state in a square well potential (E< 0): Admissible solutions of wave equation, The energy eigen values – Discrete spectrum, The energy eigen functions, parity, Penetration into classically forbidden regions, Square well: Non- localized states (E>0), The square potential barrier: Quantum mechanical tunnelling, Reflection at potential barriers and wells. [A Textbook of Quantum Mechanics by P M Mathews & K Venkatesan: 2.9, 2.10, 2.11, 2.12, 2.13]	25%
2.	**General Formalism of Wave Mechanics** The Schrödinger equation and probability for N-particle system, The fundamental postulates of wave mechanics, The adjoint of an operator and self adjointness, The eigen value problem: Degeneracy, Eigen values and eigen functions of self-adjoint operators, The Dirac delta function, Observables: Completeness and normalization of eigen functions, Closure, Physical interpretation of eigen values, eigen functions and expansion coefficients, Momentum eigen functions: wave functions in momentum space. [A Textbook of Quantum Mechanics by P M Mathews & K Venkatesan: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10]	25%

3.	**Uncertainty Principle & SHO** The uncertainty principle, States with minimum value for uncertainty product, Commuting observables; removal of degeneracy, Evolution of system with time; constants of the motion, Non-interacting and interacting systems, Systems of identical particles **The Simple Harmonic Oscillator:** The Schrödinger equation and energy eigen values, The energy eigen functions: Series solution; Asymptotic behaviour. [A Textbook of Quantum Mechanics by P M Mathews & K Venkatesan: 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 4.1, 4.2]	25%
4.	**Exactly Soluble Eigen value Problem** **Angular Momentum and Parity:** The angular momentum operators, The eigen value equation for L^2; Separation of variables, Admissibility conditions on solutions; eigen values, The eigen functions: Spherical harmonics, Physical interpretation **Angular momentum in stationary states of system with spherical symmetry:** The rigid rotator, A particle in a central potential; The radial equation, The radial wave function, The Hydrogen Atom: Solution of the radial equation and energy levels, The Anisotropic oscillator, The Isotropic oscillator. [A Textbook of Quantum Mechanics by P M Mathews & K Venkatesan: 4.6, 4.7, 4.8, 4.9, 4.10, 4.12, 4.15, 4.16, 4.20, 4.21]	25%

Teaching-Learning Methodology	Direct Teaching through Chalk-Walk and Talk ICT enabled teaching Question-Answer Class discussion led by teacher/students Case Studies Literature review Problem solving activities Debate Collaborative and Co-operative Learning Think Pair Share Jigsaw Inquiry Based Learning Panel Discussion Project Based Learning Flipped Classroom Blended Learning designs Concept Mapping

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the basic concepts and describe the main features of the historical development of quantum physics.
2.	solve the Schrödinger equation for standard systems with both analytical and numerical methods, and then interpret the results.
3.	Understand the requirement of normalization of the wave function, interpretation of the normalized wave function etc.
4.	Get familiar with the methods of solving exactly solvable problems and explain the physical states of elementary particles and atoms in different systems based on quantum mechanics.

Suggested References:	
Sr. No.	**References**
1.	A Textbook of Quantum Mechanics P M Mathews and K Venkatesan (2nd Edition) Tata McGraw Hill, New Delhi
2.	Introduction to Quantum Mechanics David J Griffiths (2nd Edition) Pearson
3.	Quantum Mechanics Theory and applications Ajoy Ghatak and S Lokanathan, McMillan Publishers India Limited, Delhi
4.	Quantum Mechanics Leonard I Schiff McGraw Hill Book Co.

On-line resources to be used if available as reference material
On-line Resources
https://www.livescience.com/33816-quantum-mechanics-explanation.html https://www.britannica.com/science/quantum-mechanics-physics http://ursula.chem.yale.edu/~batista/classes/vvv/FiniteSquareWell.pdf http://www.iitg.ac.in/physics/fac/charu/courses/ph405/Formalism.pdf https://en.wikipedia.org/wiki/Uncertainty_principle https://en.wikipedia.org/wiki/Quantum_harmonic_oscillator http://www.nat.vu.nl/~wimu/EDUC/MNW-lect-2.pdf

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Bachelor of Science
B.Sc. Physics (Semester -VI)

Course Code	US06MAPHY02	**Title of the Course**	Solid State Physics & Nuclear Physics
Total Credits of the Course	04	**Hours per Week**	04

Course Objectives:	1. To train the students in various methods like X-ray diffraction to understand the structure and symmetry of crystalline materials. 2. To create awareness about basic theoretical approaches and approximations to study the electrical and thermal conductivity of materials. 3. To provide an exposure to general properties of nucleus, nuclear reactions, estimation of energy release during nuclear reactions like fission, the Q-value equation. 4. To understand the nucleus and its properties by treating it as a charged liquid drop model. 5. To create awareness about functions of nuclear detectors and accelerators.

Course Content		
Unit	**Description**	**Weightage (%)**
1.	**<u>X-ray diffraction</u>:** Introduction, Reciprocal lattice, Bragg's law, Laue's interpretation of X-Ray diffraction by crystal, construction of reciprocal lattice, relation between a , b , c and a*, b*, c*, Application to some crystal lattice (SC, BCC HCP) , Measurement of diffraction pattern of crystal, The Ewald construction, Experimental methods (The Laue method, The Oscillation method, The powder method), Analysis of X-ray diffraction pattern from crystal, Structure factor for bcc crystal, Structure factor of mono atomic FCC crystal, Measurement of diffraction pattern of crystals, The Ewald construction, Experimental methods (The Laue method, The Oscillation method, The Powder method), Selection of incident beam (X-rays, Neutrons, Electrons) [Elements of Solid State Physics by J. P. Srivastava (4th Edition): 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.8.1, 3.8.2, 3.10]	25%

2.	**Free electron Fermi Gas:** Introduction of the free electron gas, Drude model, DC electrical conductivity of metals, Thermal conductivity of metals, Lorentz modification of the Drude model, Energy level in one dimension, Effect of temperature on the Fermi-Dirac distribution, Free electron gas in three dimensions, Heat capacity of the electron gas, Experimental heat capacity of metals, Electrical Conductivity and Ohm's Law, Experimental Electrical resistivity of metals, Motion in magnetic field, Hall effect [Elements of Solid State Physics by J. P. Srivastava (4th Edition): 6.1, 6.1.1, 6.1.2, 6.2, Introduction to Solid State Physics by Charles Kittle (8^{th} Edition): Page no: 134-156]	25%
3.	**General Properties of Nucleus, Q–Equation and Liquid Drop Model of Nucleus:** Constituents of Nuclei and their intrinsic properties, Nuclear size, Nuclear mass - Aston's mass spectrograph and Dempster's mass spectrometer, Nuclear angular momentum, Nuclear magnetic moment, Electric quadrupole moment, Wave mechanical properties -parity and statistics, Non-existence of electron in nucleus, Neutron-proton hypothesis, Binding energy, Types of nuclear reactions, Balance of mass and energy in nuclear reactions, The Q equation, Solution of Q equation, Weizsacher's semi empirical mass formula. [Introductory Nuclear Physics R.K. Puri and V.K. Babbar 1.1 to 1.10] [Nuclear Physics: An introduction S.B. Patel 3.2, 3.3, 3.4, 3.5,5.3]	25%
4.	**Detectors and Accelerators:** **Accelerators:** Introduction, Cockcroft and Walton Generator, Van de Graff Accelerator, Tandem accelerator, Linear Accelerator or Drift Tube accelerator, Magnetic resonance accelerators or cyclotron Betatron, Synchrocyclotron or frequency modulated cyclotrons. **Detectors:** Introduction, Gas filled detectors, Ionization chamber, Geiger-Muller counter, Cloud chamber, Bubble chamber, Spark chamber [Nuclear and Particle Physics V. K. Mittal, R. C. Verma, S. C. Gupta (2^{nd} edition) 6.1 to 6.5, 6.7 to 6.9, 7.1 to 7.3, 7.5, 7.8 to 7.10]	25%

Teaching-Learning Methodology	Direct Teaching through Chalk-Walk and Talk ICT enabled teaching Question-Answer Class discussion led by teacher/students Case Studies Literature review Problem solving activities Debate Collaborative and Co-operative Learning Think Pair Share Jigsaw Inquiry Based Learning Panel Discussion Project Based Learning Flipped Classroom Blended Learning designs Concept Mapping

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: On the successful completion of the course, the students will be able to understand:	
	The application of X-ray diffraction techniques to determine the structure and symmetry of various solid materials.
	The electrical and thermal conductivity of metals based on free electron gas model and the effect of free charge carriers under electric and magnetic fields.
	The basic properties of nucleus, different types of nuclear reaction processes and Q- value equation through which the energy release in nuclear reactions like fission can be estimated.
	Properties of nucleus by considering analogy of nucleus with a drop of liquid.
	The experimental techniques used to produce highly energetic nuclear and sub nuclear particles in accelerators.
	The functions of and applicability of different detectors used to detect nuclear and sub nuclear particles.

Suggested References:

Sr. No.	References
1.	Elements of Solid State Physics J. P. Srivastava (4th Edition) PHILearning Pvt. Ltd.
2.	Introduction to Solid State Physics Charles Kittel (8th Edition) Wiley India Pvt. Ltd.
3.	Solid State Physics S.O. Pillai (7th Edition) New Age International Publisher
4.	Introductory Nuclear Physics R. K. Puri and V. K. Babbar Narosa Publishers (1996)
5.	Nuclear Physics – An Introduction S. B. Patel New Age International Publishers (2nd Edition)
6.	Nuclear and Particle Physics V. K. Mittal, R. C. Verma, S. C. Gupta (2nd edition) PHI Learning Pvt. Ltd. (2011)
7.	Fundamentals of Nuclear Physics D.R.S. Somayajulu, Roop Chand Bhandari and Jagdish Varma BS Publishers & Distributers Pvt. Ltd. (2005)

On-line resources to be used if available as reference material

On-line Resources:

X-Ray diffraction
http://web.pdx.edu/~pmoeck/phy381/Topic5a-XRD.pdf
https://en.wikipedia.org/wiki/X-ray_crystallography
Free Electron Fermi gas
https://en.wikipedia.org/wiki/Fermi_gas
http://www.phys.nthu.edu.tw/~spin/course/104F/Kittel-Chapter%206-Tina.pdf
General Properties of Nucleus
Resource Type: Reference:
https://www.hep.phy.cam.ac.uk/~chpotter/particleandnuclearphysics/Lecture_13_BasicNuclearProperties.pdf
https://inpp.ohio.edu/~meisel/PHYS7501/file/Lecture1_Properties_PHYS7501_F2019_ZM.pdf
http://inside.mines.edu/~kleach/PHGN422/lectures/Lecture4.pdf
Detectors and Accelerators
https://en.wikipedia.org/wiki/Van_de_Graaff_generator
https://www.britannica.com/technology/particle-accelerator/Cyclotrons
https://www.studyandscore.com/studymaterial-detail/geiger-muller-counter-construction-principle-working-plateau-graph-and-applications

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Bachelor of Science
B.Sc. Physics Practical (Semester-VI)

Course Code	US06MAPHY03	Title of the Course	PHYSICS PRACTICAL
Total Credits of the Course	4	Hours per Week	8

Course Objectives:	1. To impart practical knowledge by performing experiments based on the principles of theory courses. 2. To provide hands on experience with equipments such as CRO, Interferometer electronic circuits etc. 3. To provide training how to analyze the experimental observations and draw conclusions with quantitative measurements.

Course Content	
Description	**Weightage (%)**
SECTION A: 1. Numerical study of harmonic motion (simple and damped) 2. Susceptibility of paramagnetic /ferromagnetic solution by Quink's method 3. Determination of unknown frequency by Wein-bridge oscillator 4. Bistable Multivibrator 5. Operational amplifier applications (Integrator, Differentiator, Adder, Subtractor, log amplifiers and Comparator) 6. Four Bit Binary Up and Down Counters 7. Planck's constant by LED	50%
SECTION B: 1. Michelson Interferometer (measurement of $d\lambda$) 2. Square well potential 3. Characteristics of LDR 4. Fabry–Pérot Etalon 5. Numerical integration 6. Hall effect (constant probe current) 7. Determination of lattice parameters from a photograph (Electron diffraction ring pattern)	50%

NOTE	Minimum 80% practical should be performed. To provide flexibility up to the maximum of 20% of total experiments can be replaced/ added to the list by respective colleges.

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	The basic principles of Physics related to their courses in a practical way.
2.	The operational details of CRO, Interferometer and electronic circuits etc.
3.	The experimental design aspects to determine various properties of materials like resistivity, Hall coefficient, energy band gap, thickness of film etc.
4.	The process to analyze the observations and infer the outcome of the experiment.

Suggested References:	
Sr. No.	**References**
1.	Advanced Practical Physics for students B L Worsnop and H T Flint, Methuen and Co. Ltd., London
2.	B.Sc. Practical Physics C L Arora, S. Chand & Co. Ltd., New Delhi
3.	Advanced Practical Physics M S Chauhan and S P Singh, Pragati Prakashan, Meerut
4.	Advanced Practical Physics S L Gupta and V Kumar, Pragati Prakashan, Meerut
5.	An advanced course in practical Physics D Chattopadhyay and P C Rakshit, New Central book agency Pvt. Ltd.

On-line resources to be used if available as reference material
On-line Resources
SUSCEPTIBILITY OF PARAMAGNETIC/FERROMAGNETIC SOLUTION BY QUINK'S METHOD https://www.holmarc.com/magnetic_susceptibility_quinke.php#:~:text=The%20Quincke's%20Method%20is%20used,a%20non%2Duniform%20magnetic%20field.&text=Measuring%20this%20rise%20enables%20to%20determine%20the%20susceptibility%20of%20the%20solution. https://www.youtube.com/watch?v=yzgdq8uUfO4 FEBRY- PAROT ETALON https://en.wikipedia.org/wiki/Fabry%E2%80%93P%C3%A9rot_interferometer https://www.csustan.edu/sites/default/files/groups/Write%20to%20Live/physics/sample-average1.pdf https://www.youtube.com/watch?v=9fbLu5MjAno https://www.youtube.com/watch?v=HkjlfCiEqGE (ELECTRON DIFFRACTION RING PATTERN) Determination of lattice parameter from a photograph https://www.intechopen.com/books/modern-electron-microscopy-in-physical-and-life- sciences/electron-diffraction http://instructor.physics.lsa.umich.edu/adv-labs/Electron_Diffraction/electron_diffraction2.pdf PLANK'S CONSTANT BY SOLAR CELL https://www.iitr.ac.in/departments/PH/uploads/Teaching%20Laboratory/Thermal/4%20Plancks%20%20Constant.pdf https://www.youtube.com/watch?v=qtSd3wYg7oE SQUARE WELL POTENTIAL https://en.wikipedia.org/wiki/Finite_potential_well#:~:text=The%20finite%20potential%20well%20(also,a%20concept%20from%20quantum%20mechanics.&text=In%20the%20quantum%20interpretation%2C%20there,walls%20(cf%20quantum%20tunnelling). https://www.youtube.com/watch?v=FL4QCymhYDA https://www.youtube.com/watch?v=WOPhz9dBOXc CHARACTERESTICS OF LDR http://eeeforum.weebly.com/uploads/1/0/2/5/10254481/e392_lab8b.pdf https://www.youtube.com/watch?v=mn8YLWMv3HM NUMERICAL INTEGRATION BY COMPUTER https://www.slideshare.net/chauhansp198/numerical-integration-59190592?qid=c7fccdec-e38f-4580-8a22-4690015bda90&v=&b=&from_search=4 https://learn.lboro.ac.uk/archive/olmp/olmp_resources/pages/workbooks_1_50_jan2008/Workbook31/31_2_num_int.pdf HALL EFFECT https://www.youtube.com/watch?v=pxdHnXV0kWc Verify the truth table of RS, JK, T and D flip-flops using NAND & NOR gates - Virtual Labs (vlabs.ac.in) Design and verify the 4-bit synchronous/asynchronous counter using JK flip flop - Virtual Labs (vlabs.ac.in)

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Bachelor of science B.Sc.
Physics Semester-VI

Course Code	US06MIPHY01	**Title of the Course**	Spectroscopy
Total Credits of the Course	2	**Hours per Week**	2

Course Objectives:	1. To investigate the production of spectra and various types of spectra and different Quantum number. 2. To understand the effects of magnetic and electric field on the spectrum of an atom i.e., Zeeman effects, Paschen-Back effects and Stark effects. 3. To study production, measurement and diffraction of X - ray radiation and Bragg's Law. The comparison of optical and X-Ray spectra.

Course Content

Unit	**Description**	**Weightage (%)**
1.	**Atomic Spectra:** Investigation of Spectra, Production of Spectra, Types of Spectra, Wave Number, Shortcomings of Bohr theory, Criticism and limitations of old quantum mechanical models, The Spinning Electron, Space Quantization, Quantum Numbers and their Physical Interpretation, Quantum numbers for complete atoms, Fine structure of Hydrogen lines, Spectral terms and their notations, Positronium, Mesonic atoms, L-S Coupling, j-j Coupling, Experimental study of Zeeman Effect, Classical Interpretation of Normal Zeeman Effect, Vector model and normal Zeeman effect, Paschen-Back effect, Stark Effect. [Elements of Spectroscopy by S L Gupta, V Kumar, R C Sharma (31st Edition) Section I: Atomic Spectra: 1.1, 1.2, 1.3, 1.4, 1.14, 2.7, 3.1, 3.2, 3.3, 3.1.1, 3.8, 3.9, 3.10, 3.11, 6.13, 9.1, 9.2, 9.3, 9.4, 9.7, 9.14]	50%
2.	**X-ray Spectra:** Production of X-rays, Origin of X-Radiations according to electromagnetic theory, X-rays: Light and Electromagnetic Spectrum, Diffraction of X-Radiations, Bragg's law, Laue spots, Bragg's spectrometer, Continuous X-ray spectrum, Characteristic Emission Spectrum, Characteristic Absorption Spectrum, A Close Survey of Emission Spectrum, Explanation of Emission and Absorption Spectra, Energy levels, Comparison of Optical and X-ray Spectra, Moseley's Law, Application of Moseley's law. [Elements of Spectroscopy by S L Gupta, V Kumar, R C Sharma (31st Edition) Section II: X-Rays and X-Ray Spectra: 1.1, 1.2, 1.3, 1.6, 1.7, 1.8, 1.9, 1.12, l.l3A, 1.13B, 1.14, 1.15, 1.16, 1.17, 1.18]	50%

Teaching-Learning Methodology	Direct Teaching through Chalk-Walk and Talk ICT enabled teaching Question-Answer Class discussion led by teacher/students Case Studies Literature review Problem solving activities Debate Collaborative and Co-operative Learning Think Pair Share Jigsaw Inquiry Based Learning Panel Discussion Project Based Learning Flipped Classroom Blended Learning designs Concept Mapping

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to

1.	Understand about Production and types of Atomic spectra and effects of magnetic and electric field on it.
2.	Understand the various parameters related with X-Ray Spectra.

Suggested References:

Sr. No.	References
1.	Elements of Spectroscopy S L Gupta, V Kumar, R C Sharma (31st Edition) Pragati Prakashan
2.	Molecular structure and Spectroscopy G Aruldhas, Prentice-Hall of India Private Limited

On-line resources to be used if available as reference material
On-line Resources
https://www.voutube.com/watch?v=FLOXW6G9P8l https://www.voutube.com/watch?v=wsCMXfQWnvM https://en.wikipedia.org/wiki/Zeeman_effect https://www.voutube.com/watch?v=vSIVDEVlv78 https://www.radiologymasterclass.co.uk/tutorials/ohvsics/x-ray_physics_production

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Bachelor of Science
B.Sc. Physics Practical (Semester – VI)

Course Code	US06MIPHY02	**Title of the Course**	Physics Practical
Total Credits of the Course	02	**Hours per Week**	04

Course Objectives:	1. To learn by performing experiments based on principles and applications. 2. To have working knowledge of equipment like thermocouple, telescope and electronic circuits. 3. To have the working knowledge of experiments related to Thermodynamics, optics, mechanics, electrodynamics, analog and digital electronics etc.

Course Content	
Description	**Weightage (%)**
1. Determination of unknown wavelength of spectra using Hartmann's formula 2. 'λ' measurement of spectral lines 3. 'L' by Anderson's bridge 4. Study of LCR Series resonance circuit 5. Study of plane diffraction grating 6. Capacitance by de Sauty's method 7. Numerical study of simple harmonic motion 8. Phonon dispersion relation of monoatomic chain 9. Determination of unknown frequency by Wein-bridge oscillator	100%

NOTE	Minimum 80% practical should be performed. To provide flexibility up to the maximum of 20% of total experiments can be replaced/ added to the list by respective colleges

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Continuous Assessment in the form of Internal Written Test, Quizzes, Assignments, Active learning, Viva-voce, Seminars, Attendance (As per NEP Guideline)	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	various properties of materials like resistivity, low resistance, energy band gap, thickness of film, wavelength of monochromatic light etc.
2.	deduce numerical methods to analyze the observational data as well as the applications of numerical methods to solve dynamics of Physics problems.
3.	study various oscillatory circuits, transistor amplifiers, operational amplifiers and digital circuits.

Suggested References:

Sr. No.	References
1.	Advanced Practical Physics for students B L Worsnop and H T Flint, Methuen and Co. Ltd., London
2.	B.Sc. Practical Physics C L Arora, S. Chand & Co. Ltd., New Delhi
3.	Advanced Practical Physics M S Chauhan and S P Singh, Pragati Prakashan, Meerut
4.	Advanced Practical Physics S L Gupta and V Kumar, Pragati Prakashan, Meerut
5.	An advanced course in practical Physics D Chattopadhyay and P C Rakshit, New Central book agency Pvt. Ltd

On-line resources to be used if available as reference material

On-line Resources

THERMOCOUPLE
https://alllabexperiments.com/wp-content/uploads/2020/12/Thermocouple-Caliberation-All-Lab-Experiments.compressed_compressed.pdf

FOUR PROBE METHOD
https://vlab.amrita.edu/?sub=1&brch=282&sim=1512&cnt=3
https://vlab.amrita.edu/?sub=1&brch=282&sim=1512&cnt=3

'Y' BY KOENIG'S METHOD
https://www.scribd.com/document/773198194/Young-s-Modulus-Koenig-s-Method
https://www.youtube.com/watch?v=V_z0AgbyfeM

RESOLVING POWER OF TELESCOPE
https://www.youtube.com/watch?v=FeIdFtcYQXg

LIGHT DEPENDENT RESISTOR
https://www.electrical4u.com/light-dependent-resistor-ldr-working-principle-of-ldr/

SOLAR CELL CHARACTERISTICS
https://www.iitr.ac.in/departments/PH/uploads/Teaching%20Laboratory/Thermal/2.%20solar%20cell.pdf
https://www.youtube.com/watch?v=1BlUC8nYuTs

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