

SRI VENKATESWARA UNIVERSITY :: TIRUPATI

Programme: B.Sc. Honours in Physics (Major)

w.e.f. AY 2023-24

COURSE STRUCTURE

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Essentials and Applications of Mathematical, Physical and Chemical Sciences	3+2	4
		2	Advances in Mathematical, Physical and Chemical Sciences	3+2	4
	II	3	Mechanics and Properties of Matter	3	3
			Mechanics and Properties of Matter Practical Course	2	1
		4	Waves and Oscillations	3	3
			Waves and Oscillations Practical Course	2	1
II	III	5	Optics	3	3
			Optics Practical Course	2	1
		6	Heat and Thermodynamics	3	3
			Heat and Thermodynamics Practical Course	2	1
		7	Electronic Devices and Circuits	3	3
			Electronic Devices and Circuits Practical Course	2	1
		8	Analog and Digital Electronics	3	3
			Analog and Digital Electronics Practical course	2	1
	IV	9	Electricity and Magnetism	3	3
			Electricity and Magnetism Practical Course	2	1
		10	Modern Physics	3	3
			Modern Physics Practical Course	2	1
		11	Introduction to Nuclear and Particle Physics	3	3
			Introduction to Nuclear and Particle Physics Practical Course	2	1

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
III	V	12	Applications of Electricity & Electronics	3	3
			Applications of Electricity & Electronics Practical Course	2	1
		13	Electronic Instrumentation	3	3
			Electronic Instrumentation Practical Course	2	1
		14 A	Optical Instruments and Optometry	3	3
			Optical Instruments and Optometry Practical Course	2	1
		OR			
		14 B	Optical Imaging and Photography	3	3
			Optical Imaging and Photography Practical Course	2	1
		15 A	Low Temperature Physics & Refrigeration	3	3
			Low Temperature Physics & Refrigeration Practical Course	2	1
		OR			
		15 B	Solar Energy and Applications	3	3
			Solar Energy and Applications Practical Course	2	1
	VI	Internship			
	VII		Courses will be available in due course of time		
	VIII		Courses will be available in due course of time		

S.V. UNIVERSITY 4-YEAR HONOURS DEGREE PROGRAMME

BSc (PHYSICS) HONOURS DEGREE SYLLABUS

(W.E.F. AY-2023-24)

SEMESTER – V

COURSE 12: APPLICATIONS OF ELECTRICITY AND MAGNETISM

(Theory – Credits: 3)

No. of hours per week: :3

Total contact hours: 45

COURSE OBJECTIVES (As per NAAC Model):

1. To enable students to understand the fundamental principles of electricity and magnetism and their practical applications.
2. To promote problem-solving and analytical skills through the application of theoretical concepts to real-world electrical and electronic devices.
3. To develop competencies in identifying and handling various electrical and electronic components.
4. To encourage scientific thinking and innovation through experimental learning and project-based assessments.
5. To foster interest in emerging technologies in electricity and magnetism, including energy-efficient systems, digital modulation, and smart devices.

COURSE LEARNING OUTCOMES (CLOs) (As per NAAC Model):

On successful completion of this course, students will be able to:

CLO Code	Course Learning Outcome (Mapped to Bloom's Level)
CLO 1	Identify and classify passive components such as resistors, inductors, and capacitors, and explain their applications in circuits. (Remembering, Understanding)
CLO 2	Apply Ohm's Law and network theorems to solve basic DC and AC circuit problems. (Applying)
CLO 3	Describe the construction and working principles of AC and DC generators, transformers, and motors. (Understanding)
CLO 4	Analyse amplitude and frequency modulation techniques in communication circuits. (Analysing)
CLO 5	Design and test basic power supply systems and understand troubleshooting techniques. (Creating, Evaluating)
CLO 6	Engage in hands-on experimentation and simulation to strengthen theoretical knowledge. (Applying)
CLO 7	Participate actively in co-curricular and extracurricular activities, demonstrating teamwork, communication, and technical presentation skills. (Applying, Creating)

Course Content (Syllabus):

Unit I: Passive Elements and Applications (9 Hours)

- Resistor: Types, colour coding, combinations (series/parallel), Ohm's Law, limitations
- Inductor: Principle, EMF induction, energy stored, types and combinations
- Capacitor: Principle, types, charging/discharging, colour coding
- Applications:
 - Resistors as heating and fuse elements
 - Inductors in fans, tuning circuits
 - Capacitors in motors, power supplies
 - *Introduction to smart materials such as thermistors, LDRs for sensing applications*

Unit II: Power Sources and DC Network Theorems (9 Hours)

- Power Sources: DC & AC, battery types, rechargeable batteries (Li-ion, Lead-acid), configurations
- Theorems: Thevenin's, Norton's, Maximum Power Transfer
- Applications: Voltage/current sources, SMPS in computers
- *Battery Management Systems (BMS) for Electric Vehicles and Renewable Energy Storage*

Unit III: AC/DC Generators and Transformers (9 Hours)

- AC Generator: Construction, working, types, applications
- DC Generator: Working, types, applications, losses
- Transformer: Construction, EMF equation, OC/SC tests, types (step-up/down), applications
- Motors: Single-phase motor, applications in household devices
- *Energy-efficient motors, integration with Smart Grid Systems, and IoT-enabled motor controls*

Unit IV: Modulation and Communication Circuits (9 Hours)

- Need for modulation, types: Amplitude Modulation (AM), Frequency Modulation (FM).
- Modulation index, waveforms, and power relations **of AM and FM modulations**
- Demodulation techniques: Diode detector **for AM modulation**
- AM/FM transmitters and receivers.
- *Basics of Digital Modulation (ASK, FSK, PSK), Software Defined Radio (SDR)*

Unit V: EM Induction & Power Supplies (9 Hours)

- DC Motor: Construction, operating principle, power calculation
 - Regulated Power Supply: 5V circuit design
 - Transformer design (step-up/down)
 - FM Radio circuit using LCR
 - Battery eliminator troubleshooting
 - Design of simple chargers and SMPS
 - *Wireless charging systems and USB-PD protocols*
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References (Open Access and Free Resources):

1. "Basic Electrical Engineering" by D.P. Kothari and I.J. Nagrath – [Free PDF on NPTEL](#)
2. "All About Circuits" – Open Source E-book [<https://www.allaboutcircuits.com/textbook/>]
3. NPTEL Course on Basic Electrical Circuits – [<https://nptel.ac.in/courses/108106182/>]
4. "Electric Circuits" by James W. Nilsson, Susan Riedel – INFLIBNET [<https://epgp.inflibnet.ac.in/>]
5. "Electrical Machines" by D.P. Kothari and I.J. Nagrath – e-PG Pathshala & NPTEL
6. "Electric Machinery Fundamentals" by Stephen Chapman – MIT OCW [<https://ocw.mit.edu>]
7. NPTEL: Analogue Communication [<https://nptel.ac.in/courses/108102091/>]
8. "Electronic Communication Systems" by George Kennedy – Archive.org Open Access PDF
9. Amrita Virtual Labs: Electrical Machines [<https://vlab.amrita.edu/>]
10. "Practical Electronics for Inventors" by Paul Scherz – [<https://archive.org/>]

COURSE 12: APPLICATIONS OF ELECTRICITY AND MAGNETISM

(Practical)

Number of Credits: 1

Number of hours per week: 2

Total: 30 Hours

PRACTICAL SYLLABUS

PRACTICAL COURSE OBJECTIVES

- To develop hands-on skills related to circuit construction, measurement, troubleshooting, and testing of electrical and magnetic components and devices.
 - To provide practical exposure to real-world electrical applications using standard instruments and components.
 - To promote safety awareness and accuracy in using tools like multimeters, CROs, and soldering kits.
 - To support analytical thinking and design capability through guided experiments and circuit building.
 - To integrate theory with practice for a deeper understanding of electromagnetic and circuit-based systems.
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PRACTICAL LEARNING OUTCOMES (PLOs)

After successful completion of the practical course, students will be able to:

PLO Code	Practical Learning Outcome (Mapped to Bloom's Level)
PLO1	Identify and operate various electrical components and instruments. (<i>Remembering, Applying</i>)
PLO2	Design and assemble simple electrical circuits. (<i>Applying, Creating</i>)
PLO3	Test and troubleshoot electrical circuits and devices using standard procedures. (<i>Analysing, Evaluating</i>)
PLO4	Understand and apply electromagnetic induction principles through practical demonstrations. (<i>Understanding, Applying</i>)
PLO5	Use measuring instruments like multimeters, CRO, and test equipment effectively. (<i>Applying, Evaluating</i>)

LIST OF PRACTICALS

1. Soldering techniques and practice.
 2. Design and construct a 5V DC unregulated power supply.
 3. Construction and voltage measurement of step-down transformer.
 4. Series and parallel combinations of resistors, capacitors, and inductors; measurement and verification.
 5. Use digital and analogue multimeters to measure voltage, current, and frequency (AC/DC).
 6. Test diode and transistor functionality; identify transistor type (PNP/ NPN).
 7. Construct an RLC series circuit and find the resonance frequency using an AC source.
 8. Construct an RLC parallel circuit and find the resonance frequency.
 9. Detect open and short circuits using continuity tests.
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List of Practical References

1. Soldering Techniques and Practice
References: *Laboratory Manual for Introductory Electronics Experiments* by L.K. Maheshwari & M.M.S. Anand; [Soldering is Easy PDF](#); [CSU Soldering Lab Manual](#)
2. Design and Construct a 5V DC Unregulated Power Supply
References: *Electricity-Electronics Fundamentals* by P.B. Zbar et al.; [5V DC Supply Design PDF](#); [DK Pandey Lab Manual](#)
3. Construction and Voltage Measurement of Step-Down Transformer
References: *Basic Electrical and Electronics Engineering* by S.K. Bhattacharya; [Transformer PDF Guide](#); [UNCC Transformer Lab Manual](#)
4. Series and Parallel Combinations of Resistors, Capacitors, and Inductors
References: *Laboratory Manual: Basic Electrical Engineering* by U. Agarwal; [Series-Parallel Circuits Lab PDF](#); [Tinkering Workshop Manual](#)
5. Use Digital and Analogue Multimeters (AC/DC)
References: *Electronic and Electrical Servicing* by I.R. Sinclair & J. Dunton; [Multimeter Basics PDF](#); [AX-7030 User Manual](#)
6. Test Diode and Transistor Functionality; Identify PNP/NPN
References: *Troubleshooting Electronic Equipment* by R.S. Khandpur; [Diode/Transistor Testing Guide](#); [Brown University Lab Manual](#)
7. Construct an RLC Series Circuit and Find the Resonance Frequency
References: *Basic Electrical and Electronics Engineering* by S.K. Bhattacharya; [Iowa RLC Circuit Lab PDF](#); [UNCC RLC Resonance Manual](#)
8. Construct an RLC Parallel Circuit and Find the Resonance Frequency
References: *Electricity-Electronics Fundamentals* by P.B. Zbar et al.; [UoAnbar RLC Lab Manual](#); [NYU RLC Resonance PDF](#)
9. Detect Open and Short Circuits Using Continuity Tests
References: *Electronic and Electrical Servicing* by Sinclair & Dunton; [DK Pandey Lab Manual](#); [AX-7030 User Manual](#)

STUDENT ACTIVITIES (Co-Curricular and Extra-Curricular)

- **Mandatory Activities:**
 - Field visits to local electronics repair shops, motor winding workshops, or university instrumentation labs.
 - Submission of a fieldwork/project report documenting observations and learning (max 10 pages).
 - Minimum 15 hours of guided training by teachers or experts in lab and field.
- **Suggested Co-Curricular Activities:**
 - Technical assignments (component identification, circuit design, safety protocols).
 - Seminars, group discussions, quizzes, and debates on related electrical and electronic topics.
 - Video preparation demonstrating the use of electrical tools and devices.
 - Collection and documentation of technical materials (photos, diagrams) on motors, transformers, etc.
 - Visits to electrical/electronic industries, research labs, or academic centres.
 - guest lectures from industry and academia.
 - *Recent development: Student projects on renewable energy systems, smart appliances, and IoT in electrical devices.*

CONTINUOUS EVALUATION METHODS (As per NAAC Guidelines)

- Unit Tests and Internal Examinations (written and practical).
- Surprise quizzes on recent topics using online platforms like Kahoot!, Quizizz.
- Assignments and project submissions are evaluated on technical content and presentation.
- Lab performance and report evaluation.
- Seminar and presentation assessments.
- Use of SWAYAM and NPTEL quizzes and certification for knowledge validation.
- Peer evaluation and group activity assessments.

USEFUL RESOURCES

- **For Teachers:**
 - NPTEL Video Lectures and e-Books: <https://nptel.ac.in/>
 - INFLIBNET e-PG Pathshala: <https://epgp.inflibnet.ac.in/>
 - SWAYAM Platform Courses: <https://swayam.gov.in/>
 - Amrita Virtual Labs: <https://vlab.amrita.edu/>
- **For Students:**
 - All About Circuits e-book: <https://www.allaboutcircuits.com/textbook/>
 - MIT Open Courseware Electrical Machines: <https://ocw.mit.edu>
 - Free electronics textbooks on Archive.org

- Interactive simulations on PhET: <https://phet.colorado.edu/>
 - Online courses on Coursera and EdX related to electrical engineering basics (free audit mode)
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QUIZ AND SEMINAR TOPICS

- Principles and applications of resistors, capacitors, and inductors.
 - Network theorems and their applications in circuit design.
 - Working and types of electrical machines.
 - Modulation techniques and communication circuits.
 - Recent advancements in electric motors and power supplies.
 - Emerging trends: Renewable energy integration, IoT in electrical devices.
 - Guest lecture topics: Smart grids, energy-efficient appliances, advances in battery technology.
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FIELD VISIT SUGGESTIONS

- Local electronics and motor repair workshops.
 - University research labs in electrical and instrumentation engineering.
 - Nearby electrical manufacturing or power supply companies.
 - Renewable energy plants (solar/wind).
 - Electronics industries focusing on embedded systems and IoT.
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EXTRA READING & RESEARCH PAPER REFERENCES

- Papers on energy-efficient motor design and smart grids in journals like IEEE Xplore, available via ONOS/Open Access.
 - Research on modulation techniques and communication circuits from IEEE Communications Magazine.
 - Articles on battery management and power electronics from Elsevier journals (open access versions).
 - Encourage students to participate in seminars and present papers based on these readings to develop a scientific temper and communication skills.
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SRI VENKATESWARA UNIVERSITY
4-YEAR BSc (PHYSICS) HONOURS DEGREE EXAMINATION
(W.E.F. AY-2023- 24)

COURSE 12: APPLICATIONS OF ELECTRICITY AND MAGNETISM

MODEL QUESTION PAPER

Time: 3 Hours

(Semester-V)

Max. Marks: 75

Section A

Answer any five of the following. Each question carries 5 marks.

(5 × 5 = 25 marks)

1. Explain the principle of energy storage in inductors and their use in tuning circuits.
2. Compare the characteristics of Li-ion and lead-acid batteries.
3. State and explain Thevenin's Theorem with a suitable example.
4. What are the losses in a DC generator and how do they affect efficiency?
5. Define modulation index. How does it affect AM wave characteristics?
6. Describe the construction and working of a diode detector for AM demodulation.
7. Explain the construction and principle of a DC motor.
8. Write a short note on thermistors and LDRs in sensing applications.

Section B

Answer all five questions. Each question carries 10 marks.

(5 × 10 = 50 marks)

9. (a) Describe different types of resistors with colour coding. Explain their applications in heating and fuse circuits.

OR

(b) Explain the working of capacitors in motors and power supplies. Add notes on smart passive components.

10. (a) Discuss different types of batteries and their configuration. How is BMS important in Electric Vehicles?

OR

(b) Explain Norton's Theorem with a circuit diagram. Give one practical application.

11. (a) With a neat diagram, explain the construction and working of a single-phase transformer. Derive its EMF equation.

OR

(b) Discuss the working of a single-phase motor. How are energy-efficient motors integrated with smart grids?

12. (a) What is the need for modulation? Compare AM and FM with waveforms and power relations.

OR

(b) Explain any two digital modulation techniques and give an overview of Software Defined Radio (SDR).

13. (a) Design a regulated 5V power supply and explain the role of each component.

OR

(b) Discuss the construction and working of wireless charging systems. Explain USB-PD protocols with examples.

S.V. UNIVERSITY 4-YEAR HONOURS DEGREE PROGRAMME

BSc (PHYSICS) HONOURS DEGREE SYLLABUS

(W.E.F. AY-2023-24)

SEMESTER – V

Course 13: Electronic Instrumentation

(Theory – Credits: 3)

No. of hours per week: 3

Total contact hours: 45

Course Objectives (COs):

This course aims to:

1. Provide foundational knowledge of electronic measuring instruments.
2. Develop a practical understanding of instrument construction and operation.
3. Introduce display systems, transducers, signal processing, and biomedical instrumentation.
4. Emphasise precision, safety, calibration, and troubleshooting in measurements.
5. Equip students with knowledge of real-life applications of instrumentation in various fields.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO Code	Course Learning Outcome
CLO1	Identify and describe the components of a basic instrumentation setup
CLO2	Distinguish between analogue and digital measuring instruments
CLO3	Demonstrate the use of CROs, multimeters, and function generators for measurements
CLO4	Explain the working principles of transducers and display devices
CLO5	Understand and interpret the functions of biomedical instruments like the ECG and pulse oximeter

Theory Syllabus (Total: 45 hours)

UNIT–I: Introduction to Instruments (9 hours)

- a) Basics of Measurement:** Accuracy, precision, sensitivity, resolution, range, types of errors, Classification of instruments: Analogue vs Digital, Construction and working: Analogue & Digital Multimeter (block diagram), DC/AC voltmeter, Display systems: $3\frac{1}{2}$ & $4\frac{1}{2}$ digit DMM, specifications and error analysis in resistance, voltage, and current measurements
- b) Mechanical Instruments:** Working principle of Moving Iron (MI) & Permanent Magnet Moving Coil (PMMC) instruments

UNIT–II: Oscilloscopes (9 hours)

- a) Cathode Ray Oscilloscope (CRO):** Block diagram, CRT structure and functioning, major controls
- b) Applications of CRO:** Measurement of voltage (AC/DC), time period, and frequency, Advanced types: Dual trace, Digital Storage Oscilloscope (DSO), Sampling Oscilloscope

UNIT–III: Transducers and Electrical Bridges (9 hours)

- a) Transducers:** Working of LVDT, resistive, capacitive, inductive, piezoelectric transducers
- b) AC/DC Bridge Circuits:** DC Wheatstone Bridge, AC Maxwell's Bridge, Schering Bridge, Frequency measurement: Wien Bridge

UNIT–IV: Data Converters and Display Devices (9 hours)

- a) Data Converters:** DAC: Binary ladder network, ADC: Successive Approximation ADC
- b) Display Devices:** LEDs, Seven Segment Displays (SSD): Construction, CA & CC types, LCDs: Working, applications, and limitations

UNIT–V: Amplifiers, Oscillators & Biomedical Instruments (9 hours)

- a) Signal Processing Circuits:** Classification: Voltage, power, operational amplifiers, RC Coupled amplifier: Frequency response (qualitative), Feedback: Positive and negative, Barkhausen criterion, RC phase shift oscillator
- b) Biomedical Instruments:** Working principles of: (i) ECG machine, (ii) X-Ray & Radiography
(iii) Ultrasound scanner (iv) Ventilator (v) Pulse oximeter

References

1. **H.S. Kalsi** – *Electronic Instrumentation*, McGraw-Hill, ISBN: 9780071070210 [PDF: \[McGraw-Hill eBook\]](#)
2. **Clyde F. Coombs** – *Electronic Instrument Handbook*, McGraw-Hill, ISBN: 9780071440259
3. **Mandeep Singh** – *Introduction to Biomedical Instrumentation*, PHI, ISBN: 9788120342228
4. **W.D. Cooper & A.D. Helfrick** – *Electronic Instrumentation and Measurement Techniques*, PHI, ISBN: 9788120306534

5. **A.K. Sawhney** – *Electrical and Electronic Measurements and Instrumentation*, Dhanpat Rai, ISBN: 9788177001006
6. **B.L. Theraja** – *A Textbook of Electrical Technology*, S. Chand, ISBN: 9788121924409
7. **Leslie Cromwell et al.** – *Biomedical Instrumentation and Measurements*, PHI, ISBN: 9788120300044
8. **Kishor K. Lal** – *Electronic Measurements and Instrumentation*, Pearson, ISBN: 9789332535175
9. **A.K. Sahan** – *Electrical and Electronic Measurements*, Dhanpat Rai Publications
10. **Online Resources** – IEEE Xplore, NPTEL, MIT OCW, e-PG Pathshala, Virtual Labs (IITs)

SEMESTER – V

COURSE 13 - ELECTRONIC INSTRUMENTATION (Practical)

Number of Credits: 1

Number of hours per week: 2

Total: 30 Hours

Practical Objectives

This practical component aims to:

1. Provide hands-on experience with electronic measurement and instrumentation systems.
 2. Train students in the operation, calibration, and troubleshooting of basic lab instruments.
 3. Introduce the use of biomedical instruments and display modules in real-world contexts.
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Practical Learning Outcomes

After successful completion of the practical course, students will be able to:

PLO Code	Practical Learning Outcome
PLO1	Operate and calibrate CROs, DMMs, and signal generators.
PLO2	Measure electrical parameters using standard lab equipment.
PLO3	Use display modules like SSDs for numeric and alphabetic output.
PLO4	Perform real-world biomedical measurements like body temperature and blood pressure.
PLO5	Interpret real-time physiological signals using biomedical instruments such as ECG and oximeter.

PRACTICAL SYLLABUS (*Total: 12 Experiments*)

1. DMM usage for voltage, current, and resistance (AC/DC)
2. Measuring AC/DC voltages & frequency using CRO
3. Generate and measure waveforms (sine, square) using a Function Generator
4. Display 0–9 using a seven-segment display
5. LVDT-based displacement measurement

6. Measurement of AC impedance and power factor
 7. Maxwell's bridge for inductance
 8. Temperature measurement with digital thermometer – error estimation
 9. Blood pressure measurement using a sphygmomanometer
 10. SSD display of alphabets (a–h)
 11. Observe ECG machine operation and pattern recognition
 12. Use and analyse data from the Pulse oximeter
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Lab References

1. **J.P. Navani** – *Electronic Measurements and Instrumentation*, S. Chand, ISBN: 9788121939403
2. **A. De Sa** – *Principles of Electronic Instrumentation*, Elsevier, ISBN: 9788126528992
3. **S.P. Bihari et al.** – *Electronic Measurements & Instrumentation*, Vayu Education
4. **Maheshwari** – *Laboratory Manual for Introductory Electronics Experiments*, New Age, ISBN: 9788122430282
5. **Paul B. Zbar et al.** – *Electricity-Electronics Fundamentals*, McGraw Hill, ISBN: 9780028019361
6. Web sources: NPTEL, MIT OCW, Virtual Labs (IIT Bombay), YouTube educational channels

STUDENT ACTIVITY

Mandatory Field/Project Work

Total Duration: 15 Hours (Lab: 10 hours + Field: 5 hours)

1. Teacher-led Training (Lab-based: 10 hours)

This component provides students with hands-on experience under direct faculty supervision to develop familiarity and confidence in handling instrumentation devices. Activities include:

- Demonstrations and guided operation of electronic and biomedical instruments such as CRO, DMM, ECG, SSD, and pulse oximeter.
- Practice sessions to measure electrical parameters like voltage, current, and resistance using analogue and digital multimeters.
- Hands-on testing of signal processing using function generators and oscilloscopes to observe waveforms, measure frequency, and time periods.
- Assembly and testing of simple circuits, e.g., SSD display control or audio amplifier with op-amps.
- Error analysis and calibration exercises to strengthen understanding of real-world measurement deviations and correction techniques.

2. Student Fieldwork (Field-based: 5 hours)

Each student must choose one of the following options and complete a field-based study:

Options:

- Visit to an Electronic Service Centre
 - Objective: Understand real-world troubleshooting and repair of PCB-level components.
 - Observe: Soldering, desoldering, IC replacements, diagnostics of consumer electronics.
- Visit to a Medical Diagnostic Centre
 - Objective: Observe instrumentation in clinical diagnostics (ECG, CT/MRI scan, etc.)
 - Focus: Working of ECG, signal capturing, waveform patterns, patient safety protocols.
- Visit to an Instrumentation Laboratory (in industry or academic institution)
 - Objective: Exposure to industrial-grade sensors, data acquisition systems, transducers, automation instruments.
- Student Deliverable:
 - A 10-page handwritten field report, including:
 - Title of Visit/Project
 - Date, Institution/Industry visited, Resource persons met
 - Detailed technical observations
 - Photos/diagrams (if permitted)
 - Learning outcomes and reflections
 - Conclusion and suggestions

Marks for Field Report: 5 Marks (to be internally assessed by the teacher)

Suggested Co-Curricular Activities:

These activities enhance the understanding of instrumentation through academic engagement, creativity, and self-learning:

1. Invited Talks by Industry Experts
 - Conduct guest lectures from engineers or practitioners in electronics, instrumentation, and healthcare diagnostics.
 - Topics: Automation, IoT in instrumentation, medical electronics, etc.
 2. Seminars and Debates
 - Organise student seminars or group debates on recent innovations in instrumentation, e.g., wearable biomedical devices, smart sensors.
 3. Assignments
 - Topics: Measurement error analysis, electrical safety standards, diagnostic instrumentation layouts, troubleshooting techniques.
 4. DIY Activities (At Home)
 - Example Projects:
 - Make a simple stethoscope using tubes and diaphragms
 - Construct an SSD display control circuit using a 7447 IC and a 7-segment display
 5. Poster Presentations
 - Design educational posters showing internal block diagrams and working principles of biomedical instruments such as ECG, ventilators, pulse oximeters.
 6. Tutorial/Demo Videos Creation
 - Students to record short explainer videos or tutorials on:
 - How to use a CRO
 - Demonstrating a DMM for AC/DC measurements
 - Working principle of ECG or pulse oximeter
 7. Industrial Visits to Process Plants
 - Visit industries like cement, sugar, or chemical plants to observe instrumentation in control rooms, SCADA, and sensor networks.
 8. Attend Webinars/Virtual Workshops
 - Suggested Platforms: ISRO, DRDO, BARC, NI, or startups in electronic healthcare devices.
 - Encourage participation in relevant MOOCs or online certification courses.
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Marks for Field Report: 5

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COURSE 13: ELECTRONIC INSTRUMENTATION

MODEL QUESTION PAPER

Time: 3 Hours

(Semester-V)

Max. Marks: 75

Section A

Answer any five of the following questions. Each question carries 5 marks. (5 × 5 = 25 marks)

1. Define accuracy, precision, sensitivity, and resolution with examples.
2. Explain the construction and working of a PMMC instrument.
3. Describe the basic controls on a CRO and their functions.
4. Write a short note on resistive and piezoelectric transducers.
5. Compare Digital and Analog Multimeters.
6. Explain the working of a seven segment display with CA and CC configuration.
7. State Barkhausen's criterion. What is its role in oscillator design?
8. Write the working principle of a pulse oximeter.

Section B

Answer all five questions. Each question carries 10 marks. (5 × 10 = 50 marks)

9. (a) Explain the classification of instruments. Describe the construction and working of a digital multimeter with block diagram.

OR

(b) Discuss in detail the construction and working of MI and PMMC instruments. Mention their advantages and limitations.

10. (a) Draw the block diagram of a CRO and explain the function of each block. Describe CRT structure.

OR

(b) Explain the working of a Digital Storage Oscilloscope (DSO). How can voltage, frequency, and time period be measured using a CRO?

11. (a) Describe the working of LVDT and capacitive transducers. Mention their applications.

OR

(b) Explain the working of the Wheatstone bridge and Maxwell's bridge with neat circuit diagrams.

12. (a) Explain the working of a binary ladder-type DAC and a successive approximation-type ADC.

OR

(b) Discuss the construction and applications of LEDs and LCDs. Compare their advantages and limitations.

13. (a) What are the different types of amplifiers? Explain the frequency response of an RC coupled amplifier.

OR

(b) Describe the working principles of any **three** biomedical instruments from the following:

(i) ECG machine (ii) X-Ray machine (iii) Ultrasound scanner (iv) Ventilator (v) Pulse oximeter

S.V. UNIVERSITY 4-YEAR HONOURS DEGREE PROGRAMME

BSc (PHYSICS) HONOURS DEGREE SYLLABUS

(W.E.F. AY-2023-24)

SEMESTER – V

COURSE 14A: OPTICAL INSTRUMENTS AND OPTOMETRY

(Theory – Credits: 3)

No. of hours per week: :3

Total contact hours: 45

Course Objectives:

This course aims to:

1. Introduce the fundamental principles and construction of optical instruments.
2. Develop understanding of the optical properties of lenses and image formation in microscopy and telescropy.
3. Familiarise students with biological optics, eye defects, and correction mechanisms.
4. Train students in the usage of ophthalmic devices and computer-based vision testing tools.
5. *Expose students to emerging trends in optometric technologies and smart diagnostic tools.*

Course Learning Outcomes (CLOs):

CLO

Code

Course Learning Outcome

- | | |
|------|---|
| CLO1 | Understand the construction and working principles of microscopes and telescopes. |
| CLO2 | Identify different types of eye defects and appropriate corrective lenses. |
| CLO3 | Demonstrate the use of basic and advanced microscopes. |
| CLO4 | Describe the anatomy of the human eye and the principles of image formation. |
| CLO5 | Apply knowledge of optometry tools for basic eye testing and vision correction. |
-

UNIT-WISE CONTENT DISTRIBUTION (syllabus)

UNIT I: Optical Microscopes (9h) – Simple microscope: construction, magnifying power, normal adjustment; Compound microscope: construction, magnifying power, adjustment; Phase contrast microscope: operating principle, biological uses; Travelling microscope: construction, working, uses; Digital/smartphone-based microscopes: intro and applications.

UNIT II: Telescopes (8h) – Refracting and reflecting telescopes: construction, working, magnifying power; Astronomical and terrestrial telescopes; Binoculars: working, uses; Intro to adaptive optics and space telescopes (e.g., Hubble).

UNIT III: Applications of Optical Instruments (10h) – Applications of: (i) Optical microscopes (compound, stereo, confocal); (ii) Electron microscopes (TEM, SEM); (iii) Scanning probe microscopes; (iv) Scanning acoustic microscopes; (v) X-ray microscopes; Applications of: (i) Optical; (ii) Radio; (iii) Solar; (iv) Infrared; (v) UV telescopes; Recent advances: LIDAR, optical coherence tomography.

UNIT IV: Optical Vision (9h) – Eye as an optical instrument; Eye vs. camera; Ophthalmic lenses: types, uses; Myopia, hypermetropia: causes, correction; Contact lenses: working, types, materials; Blue light filters, anti-reflective coatings.

UNIT V: Ophthalmic Techniques & Optometry (9h) – Ophthalmoscope, keratometer: working; Eye disorder evaluation; Standardised eye charts, vision testing protocols; Simple phoropter: use; Computer-based testing: automated refraction, mobile apps; Tele-optometry, remote diagnostics

Recommended Reference Books and Open Access Resources:

1. **Optics and Optical Instruments: An Introduction** – B. K. Johnson, Dover Publications, ISBN: 9780486439356
2. **Modern Optical Instruments and their Construction** – Oxford Henry, BiblioLife, ISBN: 9781110517337
3. **A Text Book of Optics** – Brij Lal & N. Subrahmanyam, S. Chand & Co., ISBN: 9788121908177
4. **Practical Optics** – Naftaly Menn, Elsevier Science, ISBN: 9780080523771
[Open Access PDF via ScienceDirect (campus login or library access)]
5. **Applications of Optics in Daily Life** – CK-12 Foundation
[Free E-book Access: https://flexbooks.ck12.org/cbook/ck-12-physics-flexbook/](https://flexbooks.ck12.org/cbook/ck-12-physics-flexbook/)
6. **OpenStax Physics for Health Science Majors** – Free textbook
<https://openstax.org/books/anatomy-and-physiology/pages/10-1-overview-of-muscle-tissues>
(relevant optics applications in health sciences)
7. *Other web sources and videos as recommended by the faculty and librarian.*

SEMESTER-V
COURSE 14A: OPTICAL INSTRUMENTS AND OPTOMETRY
(Practical)

Credits: 1

Hours/week: 2

Practical Objectives:

The practical course on *Optical Instruments and Optometry* is designed to:

1. Provide hands-on training in the operation and calibration of optical instruments used in optometry and related fields.
2. Train students to identify, assemble, and troubleshoot optical systems such as microscopes, telescopes, and ophthalmic lenses.
3. Enable students to perform precise measurements of focal length, lens power, and refractive errors using experimental setups.
4. Introduce students to computer-based and mobile-assisted eye testing techniques for vision assessment.
5. Demonstrate the application of optical tools in biological and medical testing, including sample observation and evaluation.

Practical Learning Outcomes (PLOs):

PLO Code	Practical Learning Outcome
PLO1	Identify, list, and handle key optical instruments such as microscopes, telescopes, and binoculars.
PLO2	Operate various optical instruments with appropriate procedures and safety protocols.
PLO3	Demonstrate the ability to test lens power, improve resolution, and align telescopic/microscopic systems.
PLO4	Measure focal length and detect refractive errors using simple and compound lenses.
PLO5	Perform optical techniques for observing biological samples and testing their properties.
PLO6	Understand and operate computer-based and mobile eye testing setups.

Practical Syllabus (List of Experiments):

1. Evaluate the magnifying power of the simple microscope.
2. Measure reflection and transmission coefficients of materials using a microscope.
3. Determine the resolving power of the telescope.
4. Measure radii of capillary tubes using a travelling microscope.
5. Determine the refractive index of water using (i) a concave mirror and (ii) a convex lens with a plane mirror.
6. Correct refractive errors using a combination of ophthalmic lenses.
7. Find the power of a convex lens using the focal length method.
8. Observe blood and biological samples under the microscope (*e.g., cheek cells, onion skin*)..
9. *Demonstration of automated refractometers or mobile-apps-based eye testing systems.*

References (Print and Open Access):

1. **A Practical Guide to Experimental Geometrical Optics** – Yuriy A. Garbovskiy, Anatoliy V. Glushchenko (Cambridge University Press), ISBN: 9781107188825
2. **Basic Optics Experiments**, University of New Mexico – <http://www.phys.unm.edu/~opticslab/>
3. **Columbia University Physics Lab Manual** – <https://physics.columbia.edu/sites/default/files/content/Lab%20Resources/1292%20Lab%20Manual.pdf>
4. **LNMIIT Physics Lab Manual** – https://www.lnmiit.ac.in/Department/Physics/uploaded_files/lab-manual.pdf
5. **Optics Lab Procedures: Telescope & Microscope** – http://www.phy.olemiss.edu/~thomas/weblab/Optics_lab_Items/Telescope_Microscope_PRO_CED_Spring_2018.pdf
6. **A.K. Khurana**, *Theory and Practice of Optics and Refraction*, Elsevier, ISBN: 9788131221798 (*for eye testing and lens correction*)
7. **Nazir A. Khan**, *Practical Optometry*, Jaypee Brothers, ISBN: 9789351524577 (*for clinical optometry skills*)
8. **Peek Vision Toolkit** (Digital Eye Testing): <https://www.peakvision.org>
9. **WHO eHealth Series – Vision Screening Tools**: Open Access PDF
10. **Eye Net Magazine (AAO)** – *Digital Innovations in Vision Testing*: Open Access Articles
11. Additional web resources and virtual labs as suggested by the faculty.

Co-Curricular Activities

(A) Mandatory Activities

Total Duration: Minimum 15 hours (Lab: 10 hrs + Field: 5 hrs)

1. Teacher Role: Field & Lab Training

The teacher (or local expert) shall train students in:

- Identification and use of various optical instruments (microscope, telescope, ophthalmoscope, etc.)
- Construction and comparison of telescopes (refracting vs reflecting types)
- Understanding the construction of the eye and defects like myopia, hypermetropia, and astigmatism
- Overview of contact lens technologies – design, materials, usage
- Clinical microscopy: preparation and observation of biological samples

2. Student Role: Field Visit & Report Submission

Each student must individually visit and observe optical instruments at one of the following:

- (a) Pathological laboratory
- (b) Local ophthalmologist
- (c) Local optician
- (d) Computer-based eye testing centre
- (e) Contact lens technician
- (f) Cinema theatre (for understanding projection optics)
- (g) Planetarium

Report Submission (Max 10 pages):

- i. Title Page
- ii. Student Details
- iii. Index Page
- iv. Place Visited
- v. Observations
- vi. Findings
- vii. Acknowledgements

Max Marks: 05

(B) Suggested Co-Curricular Activities

Activity	Description & Examples
1. Industrial/Expert Training	Organise training sessions with optical engineers, optometrists, or industry professionals.
2. Technical assignments	Identify tools in lens grinding, frame fitting, and cleaning; explain safety measures and maintenance protocols.
3. Group Learning Activities	Organise seminars, group discussions, quizzes, and debates on topics like optical vision, eye care, and optical technologies.
4. Video Documentation	Create short videos explaining the working of microscopes, telescopes, or contact lenses using real or model instruments.
5. Model Making - Microscope	Make a simple microscope using two lenses or a smartphone camera; estimate magnification.
6. DIY Astronomical Telescope	Build a telescope using cardboard and lenses; observe the moon or distant objects.
7. Lens Power Estimation:	Check the approximate power of spectacles or lenses at home using printed text and distance tests.
8. DIY Binoculars:	Make binoculars from cardboard and lenses; test image clarity and field of view.
9. Lens Image Collection:	Collect and organise images and specifications of different ophthalmic and optical lenses.
10. Visit to Eye Labs/Research Centres:	Organise visits to research centres, vision science labs, or Advanced Optometry Labs.
11. Guest Lectures:	Invite professionals from optical industries, hospitals, or research institutions to give talks on new developments.

Evaluation Components:

- Internal Tests (IE)
- Assignments
- Seminars
- Quiz
- Posters, 2D, 3D model preparation
- Field/Project Work (Max Marks: 5)
- Semester-end Practical and Theory Exams

SRI VENKATESWARA UNIVERSITY
4-YEAR BSc (PHYSICS) HONOURS DEGREE EXAMINATION
(W.E.F. AY-2023- 24)
COURSE 14A: OPTICAL INSTRUMENTS AND OPTOMETRY

MODEL PAPER

Time: 3 Hours

(Semester-V)

Max. Marks: 75

Section A

Answer any five questions. Each question carries 5 marks.

(5 × 5 = 25 marks)

1. Explain the construction and working of a simple microscope.
2. Compare astronomical and terrestrial telescopes.
3. Write short notes on stereo and confocal microscopes.
4. Describe the eye as an optical instrument.
5. What are the types and uses of ophthalmic lenses?
6. Explain the working of a keratometer.
7. What are the applications of infrared and UV telescopes?
8. Discuss the concept of digital/smartphone-based microscopes and their applications.

Section B

Answer all five questions. Each question carries 10 marks.

(5 × 10 = 50 marks)

9. (a) Describe the construction, working, and magnifying power of a compound microscope.

OR

(b) Explain the principle and applications of phase contrast and travelling microscopes.

10. (a) Describe the construction and working of a reflecting telescope. Explain the concept of magnifying power.

OR

(b) Write a detailed note on binoculars, adaptive optics, and space telescopes with an example.

11. (a) Explain the applications of scanning probe microscopes, X-ray microscopes, and LIDAR.

OR

(b) Discuss the working principles and applications of electron microscopes (SEM & TEM).

12. (a) Explain myopia and hypermetropia with ray diagrams. How are these corrected using lenses?

OR

(b) Describe the working and materials of contact lenses. Add notes on blue light filters and anti-reflective coatings.

13. (a) Describe the working of an ophthalmoscope and the use of a phoropter in vision testing.

OR

(b) Discuss modern ophthalmic techniques including computer-based testing, mobile apps, and tele-optometry.

S.V. UNIVERSITY 4-YEAR HONOURS DEGREE PROGRAMME

BSc (PHYSICS) HONOURS DEGREE SYLLABUS

(W.E.F. AY-2023-24)

SEMESTER – V

COURSE 14B: OPTICAL IMAGING AND PHOTOGRAPHY

(Theory – Credits: 3)

No. of hours per week: :3

Total contact hours: 45

Course Objectives (COs):

This course aims to:

1. Introduce the fundamental principles of image formation and camera optics.
2. Provide a detailed understanding of digital photography equipment and techniques.
3. Familiarise students with natural and artificial lighting in photography.
4. Develop competencies in various photographic techniques and specialised domains.
5. Equip students with digital editing, manipulation, and post-processing skills.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO Code	Course Learning Outcome (Mapped to Bloom's Level)
CLO1	Identify and compare various types of cameras and lenses (Remember, Understand)
CLO2	Explain and apply knowledge of focal length, aperture, ISO, and exposure (Understand, Apply)
CLO3	Distinguish between natural and artificial light sources and their photographic application (Understand, Analyse)
CLO4	Operate digital cameras and apply basic to advanced image editing techniques (Apply, Analyse)
CLO5	Demonstrate different photographic shooting methods, including advanced techniques (Apply, Evaluate)

Course Content (Syllabus):

Unit I: Introduction to Photography (9 Hours)

- Principle of camera operation and image formation
- Comparison with the human eye
- Types of Cameras: Pin-hole, SLR, TLR, DSLR, Digital, Drone cameras
- *Mirrorless and smartphone cameras – recent developments*
- Care and maintenance of equipment

Unit II: Digital Photography (9 Hours)

- DSLR and mirrorless camera anatomy and working
- Types of lenses: Normal, Wide, Telephoto, Zoom, Macro
- *Tilt-shift lenses – advanced commercial photography*
- Image formation using digital sensors (CCD, CMOS)
- Image quality parameters: Resolution, ISO, Shutter speed, Aperture
- *HDR imaging, image stabilisation, burst mode – current trends*

Unit III: Photographic Light Sources (9 Hours)

- Light and its significance
- Natural sources: Sun, Moon, Ambient
- Artificial sources: Flood, Spot, Halogen, Flash, LED, Ring light, *RGB and panel lights*
- Studio photography and exposure metering
- *Use of lighting apps and modifiers*

Unit IV: Photographic Shooting Techniques (9 Hours)

- Camera lens positioning and usage
- Techniques with DSLR and mirrorless cameras
- Use of filters: UV, ND, Polarising
- Photomicrography, High-speed photography, Underwater, Medical, Astronomical
- *Infrared photography, AI-camera control*
- *Mobile-based advanced photography tools – current trend*

Unit V: Photo Manipulation and Digital Workflow (9 Hours)

- Image development and printing
- Tools: Adobe Photoshop, Lightroom, GIMP, Snapseed
- Image adjustments: Brightness, Contrast, Tonality, Colour Balance
- Image formats, conversions, storage (USB, CD, HDD, Cloud)
- *AI-based editing tools and ethical issues in manipulation – recent developments*

Reference Materials:

1. Craven, G. M., *Object and Image: An Introduction to Photography*, PHI, ISBN: 978-0136289258, [Online: <https://archive.org/details/objectimageintro0000crav>]
2. Agfa, *An Introduction to Digital Photo Imaging*, 1994, [Google Books: https://books.google.com/books/about/An_Introduction_to_Digital_Scanning_Digi.html?id=Q8td0QEACAAJ]
3. Langford, M., *Advanced Photography*, Focal Press, ISBN: 978-0240514864, [Amazon: <https://www.amazon.com/Advanced-Photography-Sixth-Michael-Langford/dp/0240514866>]
4. Krejcarek, P., *Digital Photography – A Hands-On Introduction*, Delmar, ISBN: 978-0827371316, [Online: <https://archive.org/details/digitalphotograp0000krej>]
5. Villamil, J. and Molina, L., *Multimedia – An Introduction*, Sams, ISBN: 978-1575765570, [Google Books: https://books.google.com/books/about/Multimedia_An_Introduction.html?id=37F4AQAACA_AJ]
6. Adobe Creative Cloud Photography Plan, [<https://www.adobe.com/in/creativecloud/photography.html>]; Udemy Photography Courses, [<https://www.udemy.com/topic/photography/>]
7. Additional online resources as recommended by instructors and available through INFLIBNET N-LIST: [<https://nlist.inflibnet.ac.in/>]

Note: For access to these materials through the INFLIBNET (Information and Library Network) platform, students and teachers are encouraged to utilise the INFLIBNET N-LIST program. Membership may be available through your institution's library. Please consult with your college librarian for access credentials and further assistance.

COURSE 14B: OPTICAL IMAGING AND PHOTOGRAPHY (Practical)

Number of Credits: 1

Number of hours per week: 2

Total: 30 Hours

Practical Objectives:

- To provide practical exposure to traditional and digital imaging systems
 - To train students in editing, format conversions, and camera operations
 - To introduce real-world shooting and post-processing workflows
-

Practical Learning Outcomes:

PLO Code Practical Learning Outcome

PLO1	Construct and demonstrate a pinhole camera
PLO2	Operate analogue and digital cameras effectively
PLO3	Edit and format-convert digital images and video streams
PLO4	Evaluate pixel resolution, bit depth, and image quality
PLO5	Apply filters, resizing, and transformation techniques

Practical Exercises:

1. Construction and demonstration of a pin-hole camera
 2. Image capture with a digital camera and application of edits
 3. Conversion of image formats (JPEG, BMP, PNG)
 4. Extracting an image stream from a video using software
 5. Pixel and resolution evaluation
 6. Comparing 8, 16, and 32-bit image quality
 7. Image resizing (zoom, crop, scale)
 8. Applying IR and artistic filters
 9. *Use of mobile apps for field-based editing*
 10. *Introduction to AI tools like Canva, Luminar AI*
-

Lab References with ISBNs and Online Access

1. **Brian Black**, *DSLR Photography for Beginners: Take 10 Times Better Pictures in 48 Hours or Less!*, eBookIt.com, ISBN: 9781456636036, [Amazon Link](#)
2. **Bruce Barnbaum**, *The Art of Photography: A Personal Approach to Artistic Expression* (2nd Edition), Rocky Nook, ISBN: 9781681982106, [Rocky Nook](#)
3. **John Slavio**, *Photoshop for Photographers: Training for Photographers to Master Digital Photography and Photo Editing*, Independently Published, ISBN: 9781520320885, [Amazon Link](#)
4. **YouTube Photography Tutorials:**
https://www.youtube.com/results?search_query=photography+tutorials
5. **Udemy Photography Courses:** <https://www.udemy.com/topic/photography/>
6. **SWAYAM Online Course – Digital Photography:** NPTEL/SWAYAM,
https://swayam.gov.in/nd1_noc20_ar06
7. **Amrita Vishwa Vidyapeetham Virtual Labs:**
 - **Digital Image Processing Lab:** <https://vlab.amrita.edu/?brch=268&sub=3>
 - **Biological Image Analysis Lab:** <https://vlab.amrita.edu/index.php?brch=278&sub=3>
 - **Photoelectric Effect Simulator:**
<https://vlab.amrita.edu/?brch=195&cnt=4&sim=840&sub=3>
8. **INFLIBNET N-LIST Access** (for institutional e-resources): <https://nlist.inflibnet.ac.in/>

Note: For access to these materials through the INFLIBNET (Information and Library Network) platform, students and teachers are encouraged to utilise the [INFLIBNET N-LIST](#) program. Membership may be available through your institution's library. Please consult with your college librarian for access credentials and further assistance.

Student Enrichment Activities (Aligned with NAAC Criterion 1.1 & 1.3)

Mandatory Field Work (15 Hours):

- **Faculty Role:**
 - Provide field and lab training on image formation and optical systems
 - Include modern topics: smartphone RAW shooting, drone photography, AI editing
 - **Student Role:**
 - ✓ Visit studios/labs and document:
 - Use of various digital and video cameras
 - Lighting systems (natural/artificial)
 - Photography of still and moving objects
 - AV mixing, dubbing, and editing
 - Digital post-processing and storage
 - ✓ Submit a field/project report (~10 pages)
-

(a) Suggested Co-Curricular Activities:

1. Training with professionals from local studios
2. Assignments on tools, safety, and handling techniques
3. Group discussions, seminars, and technical quizzes
4. Photography projects: Outdoor (B/W & colour) in diverse conditions
5. Photo/video documentation of sports, wildlife, events
6. Image component mapping and report file compilation
7. Studio, media house, or industrial field visits
8. Guest lectures by professionals
9. Short documentary projects or AI photo restoration

(b) Suggested Co-Curricular Activities (Enhanced)

1. Assignments on tools, safety, and handling techniques used in photography (e.g., lenses, tripods, lighting equipment, editing software, camera maintenance).
2. Group discussions on recent trends in optical imaging, image manipulation ethics, and innovations like computational photography and AI-based editing.
3. Seminars by students on topics such as: Evolution of Cameras, Role of Light in Photography, Advances in Image Sensors, Drone Photography, and Image Forensics.

4. Technical quizzes on camera types, lens properties, image formats, lighting types, editing tools, and recent technologies (e.g., mirrorless cameras, RAW format, cloud storage).
 5. Poster presentations on subtopics like Image Formation, Types of Cameras, Exposure Triangle, Sensor Technologies, Photographic Genres, etc.
 6. Preparation of 2D and 3D models (e.g., working models of pinhole camera, DSLR mechanism, image sensor layouts, lens arrangements in cameras, optical paths in microscopes).
 7. Practice sessions on digital photography under different conditions such as daylight, low light, fast movement, and themed photography (wildlife, portraits, architecture).
 8. Preparation of educational videos explaining tools and techniques of photography and editing (to be shared in classroom/YouTube).
 9. Student exhibitions displaying photo series based on selected themes or experiments (e.g., before/after editing, depth of field changes, filter effects).
 10. Visits to photo studios, media labs, photography exhibitions, or relevant industries to observe equipment handling and practical workflows.
 11. Encouraging students to submit work to online photography contests and participate in academic/creative photography forums.
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(c) Open-Access Online Resources for Supporting Co-Curricular Activities

Use of Various Digital and Video Cameras

- Cambridge in Colour – Camera tutorials
<https://www.cambridgeincolour.com/tutorials.htm>
(Basics and advanced use of DSLR, mirrorless, and lens systems)
- Adorama Learning Centre
<https://www.adorama.com/alc/>
(Free camera and lens guides, tips for different shooting scenarios)
- Digital Photography School
<https://digital-photography-school.com/>
(Free tutorials on handling cameras, settings, and gear reviews)

Lighting Systems (Natural/Artificial)

- Photography Lighting Essentials – Strobist
<https://strobist.blogspot.com/>
(Comprehensive blog on artificial lighting setups and modifiers)
- Envato Tuts+ Photography Lighting Guide
<https://photography.tutsplus.com/>
(Lessons on ambient vs. studio lighting, light angles, colour temperature)

- SWAYAM – Photography and Video Production
https://onlinecourses.swayam2.ac.in/nou22_ge02/preview
(Covers lighting for video and still photography, exposure & composition)

Photography of Still and Moving Objects

- YouTube Channel – The Slanted Lens
<https://www.youtube.com/user/theslantedlens>
(Techniques for shooting motion, portraits, product, and commercial photography)
- Nikon Learn & Explore (Free Tutorials)
<https://www.nikonusa.com/en/learn-and-explore/index.page>
(Instructional guides for capturing motion, wildlife, sports, and macro shots)

AV Mixing, Dubbing, and Editing

- Audacity – Free Audio Editing Software + Tutorials
<https://www.audacityteam.org/>
(Download + free guides on voice recording, dubbing, audio mixing)
- DaVinci Resolve – Free Video Editing Software
<https://www.blackmagicdesign.com/products/davinciresolve/>
(Professional editing, color grading, audio sync – with free tutorials on YouTube)
- OBS Studio – Open-source AV Recording and Streaming
<https://obsproject.com/>
(Use for screen recording, basic AV mixing – supported by YouTube tutorials)

Digital Post-Processing and Storage

- GIMP – Free Open-source Photo Editing Software
<https://www.gimp.org/>
(Editing similar to Photoshop – tutorials available on their site and YouTube)
- Pixlr E – Free Online Photo Editor (No Installation)
<https://pixlr.com/e/>
(Quick editing in-browser – layering, retouching, filters)
- Google Photos & Google Drive
<https://photos.google.com/>
(Cloud-based storage and sharing – automatic syncing and basic editing tools)
- SWAYAM/NPTEL – Digital Image Processing Course
https://swayam.gov.in/nd1_noc20_ee60/preview
(Post-processing basics, compression, enhancement techniques)

Open-Access Digital Tools for Optical Imaging and Photography Activities

1. Open-Access Platforms for Technical Quizzes

Platform	Features	Access Link
Google Forms + Flubaroo	Free quiz creation, auto-grading via Flubaroo add-on	https://docs.google.com/forms
Quizizz (Free tier)	Interactive quizzes, leaderboards, and reports	https://quizizz.com
Kahoot! (Basic plan)	Live quizzes and games for classroom engagement	https://kahoot.com
Moodle (Open-source LMS)	Supports quiz banks, randomisation, and timers	https://moodle.org

2. Open-Access Tools for Video Editing, AV Mixing, and Dubbing

Platform	Features	Access Link
OpenShot Video Editor	Open-source, supports multi-track editing, transitions, and audio mixing	https://www.openshot.org
Shotcut	Free, open-source non-linear video editor with wide format support	https://www.shotcut.org
Audacity	Free, open-source audio editor for dubbing, voiceovers, and mixing	https://www.audacityteam.org
OBS Studio	Free AV recording and streaming software; useful for tutorials and voiceover projects	https://obsproject.com

3. Open-Access Tools for PPT / Presentation Creation

Platform	Features	Access Link
Canva Free	Presentation maker with drag-and-drop design, templates, and free media	https://www.canva.com
Google Slides	Web-based presentation tool with collaborative features	https://slides.google.com
Zoho Show (Free plan)	Online PPT creation and sharing tool with AI layout suggestions	https://www.zoho.com/show/
ONLYOFFICE	Open-source presentation and document editor	https://www.onlyoffice.com

Evaluation Components:

- Internal Tests (IE)
- Assignments
- Seminars
- Quiz
- Posters, 2D, 3D model preparation
- Field/Project Work (Max Marks: 5)
- Semester-end Practical and Theory Exams

SRI VENKATESWARA UNIVERSITY
4-YEAR B.Sc. (PHYSICS) HONOURS DEGREE PROGRAMME
COURSE 14B: OPTICAL IMAGING AND PHOTOGRAPHY

MODEL QUESTION PAPER (W.E.F. AY 2023–24)

Time: 3 Hours

(SEMESTER V)

(Max. Marks: 75)

PART – A

Answer any FIVE questions. Each question carries 5 marks.

5 × 5 = 25 Marks

1. Differentiate between DSLR and mirrorless cameras with examples.
2. What is the function of an aperture in a camera? How does it affect image exposure?
3. Write short notes on macro and telephoto lenses.
4. Explain the importance of ISO and shutter speed in photography.
5. Mention the types of natural and artificial light sources used in photography.
6. What is the use of Neutral Density (ND) filters? Give one application.
7. List any three post-processing software used in digital photography and their key features.
8. What are the ethical concerns in digital image manipulation?

PART – B

Answer any FIVE questions. Each question carries 10 marks.

5 × 10 = 50 Marks

9. a) Explain the principle of image formation in a camera. Compare the human eye and camera in terms of structure and image capture.

(OR)

b) Describe various types of cameras including drone and smartphone cameras. Highlight recent developments.

10. a) Describe the structure and functioning of DSLR cameras. Explain how different lenses (normal, zoom, macro) affect photography.

(OR)

b) Explain digital image formation using CCD and CMOS sensors. What are the parameters that define image quality?

11. a) Discuss the role of light in photography. Compare and contrast natural and artificial lighting with examples.

(OR)

b) Explain exposure metering in studio photography. How do lighting apps and modifiers enhance photography?

12. a) Describe various shooting techniques using filters like UV, ND, and polarising.

(OR)

b) Write a detailed note on photomicrography, high-speed, and medical photography.

13. a) What is photo manipulation? Explain the digital workflow using tools like Photoshop, Lightroom, and Snapseed.

(OR)

b) Describe different image file formats and storage options. Discuss recent AI-based editing tools and related ethical issues.

S.V. UNIVERSITY 4-YEAR HONOURS DEGREE PROGRAMME
BSc (PHYSICS) HONOURS DEGREE SYLLABUS
(W.E.F. AY-2023-24)

SEMESTER – V

COURSE 15A: LOW TEMPERATURE PHYSICS & REFRIGERATION

(Theory – Credits: 3)

No. of hours per week: :3

Total contact hours: 45

Course Objectives (COs):

This course aims to:

1. Provide a comprehensive understanding of the fundamental principles of low-temperature physics and refrigeration.
 2. Introduce various laboratory techniques and equipment used to achieve and measure low temperatures.
 3. Develop critical knowledge of refrigeration and air conditioning systems.
 4. Explore the classification and environmental impact of refrigerants.
 5. Familiarise students with the applications of cryogenics and refrigeration in science and industry.
-

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO Code	Course Learning Outcome
CLO1	Identify various methods and techniques used to produce low temperatures in the laboratory
CLO2	Acquire critical knowledge of refrigeration and air conditioning
CLO3	Demonstrate skills in operating refrigerators and understand refrigeration components and their accessories
CLO4	Understand the classification and properties of refrigerants, and evaluate their environmental effects
CLO5	Comprehend the applications of low-temperature physics and refrigeration

Course Content (Syllabus):

Unit I: Production of Low Temperature (9 Hours)

Production of low temperatures- Introduction, Freezing mixtures, Joule-Thomson effect, Regenerative cooling, Different methods of liquefaction of gases, liquefaction of air, Production of liquid hydrogen and nitrogen, Adiabatic demagnetisation, Properties of materials at low temperatures.

Unit II: Measurement of Low Temperature (9 Hours)

Gas thermometer and its correction and calibration, Secondary thermometers, resistance thermometers, thermocouples, Vapour pressure thermometers, Magnetic thermometers, Advantages and drawbacks of each type of thermometer.

Unit III: Principles of Refrigeration (9 Hours)

Introduction to Refrigeration- Natural and artificial refrigeration, Stages of refrigeration, Types of refrigeration - Vapour compression and vapour absorption refrigeration systems, Refrigeration cycle and explanation with a block diagram, Introductory ideas on air-conditioning.

Refrigerants-Introduction, Ideal refrigerant, Properties of refrigerant, Classification of refrigerants, commonly used refrigerants, Eco-friendly refrigerants.

Unit IV: Components of Refrigerator (9 Hours)

Refrigerator and its working, Block diagram, Coefficient of Performance (COP), Tons of refrigeration (TR) and Energy Efficiency Ratio (EER), Refrigerator components: Types of compressors, evaporators, condensers, and their functional aspects, defrosting in a refrigerator, Refrigerant leakage and detection.

Unit V: Applications of Low Temperature & Refrigeration (9 Hours)

Applications of low temperatures: Preservation of biological material, food freezing, liquid nitrogen and liquid hydrogen in the medical field, superconducting magnets in MRI, tissue ablation (cryosurgery), and cryogenic rocket propulsion systems.

Applications of refrigeration: Domestic refrigerators, Water coolers, Cold storage, Ice plants, Food preservation methods, Chemical and Process industries, Cold treatment of metals, Construction field, Desalination of water, Data centres.

References:

1. Heat and Thermodynamics by Brij Lal & Subramanyam, S. Chand Publishers.
2. Thermal Physics by S C Garg, R M Bansal & C K Ghosh, McGraw-Hill Education, India
3. Heat and Thermodynamics by M Zemansky, McGraw-Hill Education (India).
4. Low-Temperature Physics by Christian E. & Siegfried H., Springer.
5. Thermal Engineering by S. Singh, S. Pati, Ch: 18 Introduction to Refrigeration.
6. The Physics Hyper Text Book. Refrigerators. <https://physics.info/refrigerators/>
7. Refrigeration and Air Conditioning by Manohar Prasad, New age international (P) limited, New Delhi
8. A course in Refrigeration and Air Conditioning by S.C. Arora and S. Domkundwar, Dhanpatrai and Sons, Delhi
9. https://trc.nist.gov/cryogenics/Papers/Review/2017-Low_Temperature_Applications_and_Challenges.pdf
10. <https://nptel.ac.in/content/storage2/courses/112105129/pdf/RAC%20Lecture%203.pdf>
11. Other Web sources suggested by the teacher and the reading material.
<https://nptel.ac.in>

COURSE 15A: LOW TEMPERATURE PHYSICS & REFRIGERATION (Practical)

Number of Credits: 1

Number of hours per week: 2

Total: 30 Hours

Practical Objectives:

This practical course aims to:

1. Provide students with hands-on experience in working with low temperatures and refrigeration systems.
2. Develop practical skills in handling cryogenic equipment and performing temperature-related experiments.
3. Enable students to operate and troubleshoot basic refrigeration setups.
4. Train students in the preparation and application of freezing mixtures.
5. Enhance proficiency in temperature measurement techniques at low and cryogenic levels.

Practical Learning Outcomes (PLOs):

On successful completion of this practical course, students will be able to:

PLO Code	Practical Learning Outcome
PLO1	List out, identify, and handle the equipment used in refrigeration and low-temperature laboratories
PLO2	Learn the procedures for the preparation of freezing mixtures
PLO3	Demonstrate skills in developing various freezing mixtures and their applications in agriculture, medicine, and daily life
PLO4	Acquire skills in observing and measuring using various low-temperature methodologies
PLO5	Perform techniques related to refrigeration and freezing relevant to everyday applications

Practical Exercises:

Record the Principles and applications of Refrigerators and Freezers.

1. Measure the temperatures below the Melting point of Ice using a thermometer available in the Lab.
2. Make a freezing mixture by adding different salts, viz., Sodium chloride, Potassium Hydrate (KOH), Calcium chloride, to ice in different proportions and observe the temperature changes.
3. Study the operation of a refrigerator and understand the working of different parts.
4. Study the properties of refrigerants like chlorofluorocarbons, carbon, and record the lowest temperatures obtained.
5. Consider a simple faulty refrigerator and try to troubleshoot the simple problems by understanding its working.
6. Understand the practical problem of filling the Freon Gas into the Refrigerator.
7. Get the Liquid Nitrogen or Liquid Helium from the nearby Veterinary Hospital and measure their temperatures using chromel-alumel thermocouple or mercury thermometer, and observe their physical properties like colour, smell, etc, and precautions to be taken for their safe handling.
8. Preparation of freeze-dried food with Dry ice and liquid nitrogen.
9. Preparation of freeze-dried food with liquid nitrogen.

Lab References:

1. Heat and Thermodynamics by Brij Lal & N. Subramanyam, S. Chand Publishers.
2. Thermal Physics by S C Garg, R M Bansal & C K Ghosh, McGraw-Hill Education, India
3. Heat and Thermodynamics by M M Zemansky, McGraw-Hill Education (India).
4. Low-Temperature Physics by Christian E. & Siegfried H., Springer.
5. The Physics Hyper Text Book. Refrigerators. <https://physics.info/refrigerators/>
6. https://trc.nist.gov/cryogenics/Papers/Review/2017-Low_Temperature_Applications_and_Challenges.pdf
7. <https://nptel.ac.in/content/storage2/courses/112105129/pdf/RAC%20Lecture%203.pdf>
8. Other Web sources suggested by the teacher and the reading material. <https://nptel.ac.in>

Student Enrichment Activities (Aligned with NAAC Criterion 1.1 & 1.3)

Mandatory Field Work (15 Hours)

Faculty Role:

The faculty shall:

1. Train students in the laboratory and/or field for a minimum of 15 hours.
2. Demonstrate and explain techniques for Low Temperature Production.
3. Introduce various methods used in achieving low temperatures.
4. Guide students on the applications of low temperatures and refrigeration in:
 - Day-to-day life
 - Medical fields
 - Industrial processes

Student Role:

Each student shall individually undertake any one or more of the following activities:

1. Industrial/Workshop Visit:
 - Visit any one of the following:
 - A small ice plant or cold storage unit
 - An Air Conditioner (AC) repair shop
 - A Refrigerator repair shop
 - Interact with technicians to understand:
 - Construction and components
 - Working principles
 - Troubleshooting techniques
2. Refrigeration System Observation:
 - Observe various thermodynamic processes in a working refrigerator.
 - Learn techniques such as:
 - Leak detection methods
 - Air removal and charging of the unit
 - Testing for Refrigerating Capacity / Ton of Refrigeration (TR)
 - Measuring Power Input
3. Refrigerant Identification:
 - Identify refrigerant cylinders by their colour coding and standing pressure.
4. Supermarket Observation:
 - Visit the freezer aisle of a supermarket.
 - Observe the packaging and storage of various frozen fruits and products.
5. Fieldwork/Project Submission:
 - Write and submit a handwritten fieldwork/project report, not exceeding 10 pages, in the given format.

Fieldwork/Project Work Evaluation:

- **Maximum Marks: 05**

Suggested Format:

1. Title Page,
 2. Student Details
 3. Index Page
 4. Details of Place Visited
 5. Observations
 6. Findings
 7. Acknowledgements
-

(a) Suggested Co-Curricular Activities:

These activities aim to reinforce classroom and lab learning through hands-on exposure, industry interaction, creative assignments, and knowledge-sharing forums.

1. Industry-Based Training
 - Hands-on training of students by experts from factories or refrigeration-related industries.
2. Technical Assignments
 - Identify tools and components in refrigerators and freezers.
 - Learn their handling and operation techniques, with a focus on safety and maintenance.
3. Academic Interaction Activities
 - Conduct seminars, group discussions, quizzes, and debates on topics such as:
 - Cryogenics in medicine
 - Global warming and refrigerants
 - Advancements in domestic refrigeration
 - Low-temperature applications in food preservation
4. Video Documentation
 - Prepare short videos or documentaries demonstrating tools, techniques, and applications related to low-temperature systems and refrigeration.
5. Collection and Organisation Projects
 - Gather material, photos, and figures related to substances used in freezing mixtures.
 - Document their properties, availability, and applications in a well-organised file or digital scrapbook.
6. Educational Visits
 - Arrange field visits to:
 - Ice plants
 - Cold storage units
 - University/research laboratories
 - Private refrigeration service centres or manufacturing firms

7. Mini Project Ideas

- Make a mini refrigerator using thermoelectric coolers or simple insulation techniques.
- Build a water cooler using easily available materials at home.

8. Demonstration-Based Experiments

- Make hand-launched liquid nitrogen rockets (only under professional guidance).
- Conduct fun, safe experiments involving liquid nitrogen and items like:

- Strawberries
- Bananas
- Lemons
- Onions
- Mushrooms
- Eggs

(Note: These experiments must be supervised by a trained professional and performed under proper safety protocols.)

9. Guest Lectures

- Organise invited lectures or presentations by field experts, industrial technologists, or academic researchers on topics related to:
 - Modern refrigeration systems
 - Green refrigerants
 - Industrial cryogenics
 - Environmental regulations in cooling technologies
-

(b) Suggested Co-Curricular Activities (Enhanced)

- Identification of different Ozone-depleting substances (ODS) that damage the ozone layer in the upper atmosphere.
- Demonstration to illustrate the greenhouse effect and the role of carbon dioxide as a greenhouse gas using plastic water bottles, flood light lamp, beakers and temperature sensors and observe the temperature changes.

Evaluation Components:

- Internal Tests (IE)
- Assignments
- Seminars
- Quiz
- Posters, 2D, 3D model preparation
- Field/Project Work (Max Marks: 5)
- Semester-end Practical and Theory Exams

SRI VENKATESWARA UNIVERSITY
4-YEAR BSc (PHYSICS) HONOURS DEGREE EXAMINATION
(W.E.F. AY-2023- 24)

COURSE 15A: LOW TEMPERATURE PHYSICS AND REFRIGERATION
MODEL QUESTION PAPER

Time: 3 Hours

(Semester-V)

Max. Marks: 75

Section A

Answer any five questions. Each question carries 5 marks.

(5 × 5 = 25 marks)

1. Explain the Joule-Thomson effect and its significance in low-temperature production.
2. Compare different types of secondary thermometers with examples.
3. What are the differences between vapour compression and vapour absorption refrigeration systems?
4. Define Coefficient of Performance (COP) and Tons of Refrigeration (TR).
5. Write a short note on refrigerant leakage and its detection methods.
6. What are the applications of liquid nitrogen in the medical field?
7. Describe the use of cold treatment in metals using refrigeration.
8. List the properties of an ideal refrigerant.

Section B

Answer all five questions. Each question carries 10 marks.

(5 × 10 = 50 marks)

9. (a) Describe the different methods used for the liquefaction of gases. How is liquid hydrogen produced?
OR
(b) Explain regenerative cooling and adiabatic demagnetisation. Mention material properties at low temperatures.
10. (a) Describe the construction, working, and calibration of a gas thermometer.
OR
(b) Explain the working principles, advantages, and limitations of resistance and magnetic thermometers.
11. (a) Explain the refrigeration cycle with a neat block diagram. How does vapour compression refrigeration work?
OR
(b) Define refrigerants. Discuss their classification and eco-friendly alternatives.
12. (a) Describe the working of a domestic refrigerator. Explain the role of compressors and evaporators.
OR
(b) What is Energy Efficiency Ratio (EER)? Discuss the defrosting mechanism and energy-saving features in refrigerators.
13. (a) Discuss the major applications of low temperatures in science and medicine.
OR
(b) Explain any five applications of refrigeration in industries and infrastructure.

S.V. UNIVERSITY 4-YEAR HONOURS DEGREE PROGRAMME

BSc (PHYSICS) HONOURS DEGREE SYLLABUS

(W.E.F. AY-2023-24)

SEMESTER – V

COURSE 15B: SOLAR ENERGY AND ITS APPLICATIONS

(Theory – Credits: 3)

No. of hours per week: :3

Total contact hours: 45

Course Objectives (COs):

1. To introduce the fundamental concepts of solar energy and its sources.
 2. To understand the working principles and types of solar thermal collectors.
 3. To study the structure, function, and types of solar photovoltaic (PV) cells and modules.
 4. To explore energy storage methods associated with solar PV systems.
 5. To familiarise students with recent advancements and practical applications of solar energy systems.
-

Course Learning Outcomes (CLOs):

CLO Code	Learning Outcome Statement
CLO1	Understand the Sun's structure, solar radiation parameters, and their measurement techniques.
CLO2	Analyse different types of solar thermal collectors and evaluate their efficiency.
CLO3	Explain the principles, types, and parameters of photovoltaic cells.
CLO4	Describe module fabrication, system design, and recent developments in solar technology.
CLO5	Evaluate and apply energy storage technologies used in solar PV systems.

Syllabus:

Unit I: Solar Radiation and Measurement – (8 hours)

Structure of the Sun, spectral distribution of solar radiation, solar constant, zenith angle, air-mass, standard time, local apparent time, equation of time, direct, diffuse and total radiation; Pyrheliometer and pyranometer – working principles and measurement techniques. Introduction to IoT-based solar radiation sensors such as ESP32 + TSL2591 modules, LoRaWAN-enabled pyranometers, and smart weather stations for real-time solar data acquisition and monitoring.

Unit II: Solar Thermal Collectors – (10 hours)

Introduction and types of thermal collectors; Flat plate collectors – construction, working, energy balance, efficiency, and heat loss coefficient; Evacuated tube collectors; Collector efficiency factor, heat-removal factor, flow factor; Testing of flat plate collectors; Solar water heaters (natural and forced circulation); Applications – solar cookers, dryers, and desalination systems. Use of Phase Change Materials (PCMs) for thermal energy storage in solar thermal systems – concept, types of PCMs, advantages and limitations.

Unit III: Fundamentals of Solar Cells – (9 hours)

Semiconductor interface, types of junctions – homo, hetero, Schottky; Photovoltaic cell – working, equivalent circuit, output parameters (V_{oc} , I_{sc} , FF, η), quantum efficiency; I-V characteristics, series/shunt resistances and their effects, influence of temperature, inclination and light intensity. Introduction to emerging technologies: Organic solar cells and perovskite solar cells – structure, advantages, and potential applications.

Unit IV: Solar Cell Types and Module Design – (9 hours)

Types of solar cells – mono- and poly-crystalline silicon, amorphous silicon, thin films (CdTe/CdS, CIGS); multi-junction cells (double/triple junctions); bifacial solar panels (e.g., LONGi Hi-MO5, Trina Solar Vertex S+) and flexible solar panels (e.g., SunPower Maxeon, Renogy flexible monocrystalline panels) – structure, benefits, and applications; module fabrication steps, module connections in series and parallel, use of bypass and blocking diodes.

Unit V: Solar PV Systems and Energy Storage – (9 hours)

Energy storage modes in PV systems; Electrochemical storage – primary and secondary batteries (lead-acid, lithium-ion, solid-state, molten salt, lithium iron phosphate [LFP], sodium-ion batteries); Mechanical storage – flywheels; Electrical storage – supercapacitors; Battery management and charge controllers; Smart grid integration of PV systems and hybrid PV systems combining solar with other renewable sources.

References:

1. G.D. Rai, **Solar Energy Utilisation**, Khanna Publishers
2. G.N. Tiwari, **Solar Energy: Fundamentals, Design, Modelling and Applications**, Narosa Publishing
3. S.P. Sukhatme, **Solar Energy: Principles of Thermal Collection & Storage**, Tata McGraw-Hill
4. P. Jayarama Reddy, **Science and Technology of Photovoltaics**, CRC Press
5. Chetan Singh Solanki, **Solar Photovoltaics: Fundamentals, Technologies and Applications**, PHI Learning
6. Web sources:
 - https://courses.edx.org/c4x/DelftX/ET.3034TU/asset/solar_energy_v1.1.pdf
 - [https://www.sku.ac.ir/Datafiles/BookLibrary/45/John%20A.%20Duffie,%20William%20A.%20Beckman%20-%20Solar%20Engineering%20of%20Thermal%20Processes,%20Fourth%20Edition%20\(2013\).pdf](https://www.sku.ac.ir/Datafiles/BookLibrary/45/John%20A.%20Duffie,%20William%20A.%20Beckman%20-%20Solar%20Engineering%20of%20Thermal%20Processes,%20Fourth%20Edition%20(2013).pdf)
7. For Organic and Perovskite Solar Cells:
 - *Organic Photovoltaics: Mechanisms, Materials, and Devices* by Christoph J. Brabec, Ullrich Scherf, Vladimir Dyakonov (Wiley-VCH, 2014) [Printed]
 - *Perovskite Solar Cells: Principles and Applications* by Aparna Thankappan (Springer, 2020) [Printed & eBook]
 - Open access review: <https://www.mdpi.com/1996-1073/13/11/2764/pdf>
8. For Bifacial and Flexible Solar Panels:
 - *Bifacial Photovoltaics* by Tomasz J. Szlufcik, National Renewable Energy Laboratory (NREL) report (Open Access): <https://www.nrel.gov/docs/fy20osti/75283.pdf>
 - *Flexible Solar Panels and Their Applications* - IEEE Explore articles (available through institutional access or selected free papers)
 - *Flexible and Stretchable Electronics* by Takao Someya (Springer, 2013) [eBook]
9. For LFP, Sodium-ion Batteries, and Smart Grid Systems:
 - *Lithium-Ion Batteries: Basics and Applications* by Reiner Korthauer (Springer, 2015)
 - *Sodium-Ion Batteries: Present and Future* edited by Rachid Yazami, Jun Liu, et al. (Springer, 2018)
 - *Smart Grid: Fundamentals of Design and Analysis* by James Momoh (Wiley-IEEE Press, 2012)
 - Open Access: <https://www.sciencedirect.com/science/article/pii/S2352484719302799> (Review on Smart Grids and Hybrid Systems)

COURSE 15B: SOLAR ENERGY AND ITS APPLICATIONS (PRACTICAL)

Number of Credits: 1

Number of hours per week: 2

Total: 30 Hours

Practical Objectives

The practical component is designed:

1. To provide hands-on training in identifying and operating solar thermal and photovoltaic (PV) systems.
 2. To enable students to perform accurate measurement of solar radiation using standard instruments.
 3. To equip students with skills in recording and interpreting I–V characteristics of solar cells and modules.
 4. To train students in evaluating the efficiency of solar energy systems under varying environmental conditions.
 5. To develop the ability to identify, isolate, and troubleshoot faults in solar PV modules.
 6. To instil awareness of system integration, connections (series and parallel), and energy output optimisation.
 7. To familiarise students with standard procedures for the maintenance of solar energy systems.
-

Practical Learning Outcomes (PLOs)

PLO Code	Learning Outcome
PLO1	Identify key components of solar thermal and photovoltaic systems.
PLO2	Measure direct, global, and diffuse solar radiation using a pyrheliometer and pyranometer.
PLO3	Analyse I–V characteristics and calculate the efficiency of solar cells/modules.
PLO4	Evaluate performance differences in series and parallel connected PV modules.
PLO5	Detect and isolate damaged modules affecting output performance in arrays.
PLO6	Perform basic maintenance and servicing procedures for thermal and PV systems.

List of Experiments

1. Measurement of direct solar radiation using a **pyrheliometer**
 2. Measurement of global and diffuse radiation using a **pyranometer**
 3. Performance evaluation of a **flat-plate collector**
 4. I–V characteristic analysis and efficiency measurement of a **solar module**
 5. Determination of **series and shunt resistance** in solar cells/modules
 6. Efficiency comparison of two **solar modules connected in series**
 7. Efficiency comparison of two **solar modules connected in parallel**
 8. Study of input intensity effects on **solar module performance**
 9. Effect of temperature on **solar cell/module efficiency**
 10. Effect of module inclination angle on **energy output**
-

Lab References

1. **Chetan S. Solanki**, *Solar Photovoltaic: A Lab Training Manual*, Foundation Books, 2012
[Online Access: <https://nptel.ac.in/courses/115/107/115107113/>]
 2. **H.P. Garg & T.C. Kandpal**, *Laboratory Manual on Solar Thermal Experiments*, Narosa Publishing House, 2000
 3. **Renewable Energy Virtual Labs** – [NIU Renewable Lab Solar Experiments](#)
 4. DIY Solar Projects:
 - [Solar Hot Water Collector \(YouTube\)](#)
 - [Instructables – Solar Water Heater from Scratch](#)
-

(a) Mandatory Activities (Total: 15 hours; Lab: 10 hrs + Field: 5 hrs)

Teacher's Role (Minimum 15 hours)

- Lab Guidance: Train students to use:
 - Pyrheliometers and pyranometers.
 - Solar thermal collector test setups.
 - PV module efficiency evaluation kits.
- Field Demonstration:
 - Arrange practical demonstrations of rooftop solar systems in the college or nearby institutions.
 - Demonstrate connection and fault analysis in real PV arrays.

Student's Role

- Field Visit:
 - To a solar research centre, university solar lab, or industry (e.g., solar water heater unit, rooftop PV plant).
- Report Submission:
 - Prepare a handwritten report (max 10 pages) in the following format:

Fieldwork Report Format:

- Title Page
 - Student Details
 - Index Page
 - Site/Institution Details
 - Observations Made
 - Findings and Inferences
 - Acknowledgements
- **Evaluation: Fieldwork/project carries 05 marks.**

(b) Suggested Co-Curricular Activities

Activity Type	Examples
1. Guest Lectures/Expert Talks	Invite experts from MNRE, NISE, or solar startups to discuss innovations like perovskite cells or smart inverters.
2. Technical Assignments	Assign tasks like identifying the parts of a solar water heater or inverter, or writing safety procedures.
3. Interactive Sessions	Organise quizzes, group discussions, and debates on current solar technologies (e.g., flexible panels).
4. Media Projects	Students record videos demonstrating solar cooker use, or explain PV efficiency testing.
5. Brochure Collection	Compile images, cut-outs, and datasheets of real solar components (panels, batteries, inverters).
6. DIY Projects	Make low-cost solar lamps, cookers, phone chargers, or mini rooftop PV models.
7. Field Visits	To utility-scale PV power plants, solar R&D labs (e.g., NISE, TERI), or local PV installation sites.

(c) Suggested Student Activities

Activity	Description
Field Visits	Visit a solar-powered building, rooftop system, or solar farm; observe technology in action.
Hands-on Projects	Build and demonstrate a model solar water heater, cooker, or light-powered USB charger.
Workshops	Attend/host training on PV installation, inverter connection, battery care, and solar safety.
Seminars	Prepare a talk on topics like “Solar and IoT”, “Flexible Solar Films”, or “Solar in Agriculture”.

Record-Keeping Tips

- Maintain an activity logbook signed by the teacher after each lab/field session.
- Keep digital photo/video records of visits, demonstrations, and mini-projects.
- Use a checklist to track student participation in each activity.
- Store reports and brochures in a shared Google Drive/OneDrive folder for review and internal audit.

Evaluation Components:

- Internal Tests (IE)
- Assignments
- Seminars
- Quiz
- Posters, 2D, 3D model preparation
- Field/Project Work (Max Marks: 5)
- Semester-end Practical and Theory Exams

SWAYAM & NPTEL (India) – Free Online Courses

1. Solar Energy Engineering and Technology

- **Platform:** SWAYAM
- **Overview:** Comprehensive coverage of solar radiation, thermal and photovoltaic systems, and energy storage.
- **Link:** (swayam.gov.in)

2. Solar Photovoltaics: Fundamentals, Technology and Applications

- **Platform:** SWAYAM
- **Overview:** Explores various photovoltaic technologies, solar cell generations, device fabrication, and industrial applications.
- **Link:** (swayam.gov.in)

3. Elements of Solar Energy Conversion

- **Platform:** SWAYAM – NPTEL
- **Overview:** Introduces basic concepts for engineers in solar energy technology, including solar movement, irradiation prediction, and collector types.
- **Link:** (swayam.gov.in)

4. Physics of Renewable Energy Systems

- **Platform:** SWAYAM – NPTEL
 - **Overview:** Covers electricity generation using solar cells, solar heaters, mobile chargers, and cookers, along with other renewable sources.
 - **Link:** (swayam.gov.in)
-

International MOOCs (edX & Coursera)

1. Solar Energy Engineering Micro Master's Program

- **Platform:** edX (Delft University of Technology)
- **Overview:** In-depth program covering solar cell physics, PV design, system evaluation, and design for various applications.
- **Link:** (edx.org)

2. Solar Energy Basics

- **Platform:** Coursera (State University of New York)
- **Overview:** Introduces solar power systems, energy needs assessment, PV system sizing, and market growth.
- **Link:** (coursera.org)

3. Photovoltaic Systems

- **Platform:** Coursera (Technical University of Denmark)
 - **Overview:** Focuses on the design and operation of photovoltaic systems, including system components and performance analysis.
 - **Link:** ([coursera.org](https://www.coursera.org))(edx.org)
-

IN Government of India Skill Development Initiatives

1. Suryamitra Skill Development Programme

- **Implementing Body:** National Institute of Solar Energy (NISE)
- **Duration:** 3 months (600 hours)
- **Overview:** Aims to develop skilled technicians for solar power projects, covering installation, operation, and maintenance.
- **Link:** (energy.vikaspedia.in)(mnre.gov.in)

2. MNRE Human Resource Development Scheme

- **Overview:** Offers fellowships, internships, and training programs to enhance renewable energy education and training infrastructure.
 - **Link:** (mnre.gov.in)
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SRI VENKATESWARA UNIVERSITY
4-YEAR BSc (PHYSICS) HONOURS DEGREE EXAMINATION

Model Paper (W.E.F. AY-2023- 24)

COURSE 15B: SOLAR ENERGY AND ITS APPLICATIONS

Time: 3 Hours

(Semester-V)

Max. Marks: 75

PART – A

Answer any FIVE questions. Each question carries 5 marks.

5 × 5 = 25 Marks

1. Define solar constant. Mention its typical value and units.
2. Explain the role of selective coatings in flat plate collectors.
3. Distinguish between homo and hetero junctions in solar cells.
4. What are the characteristics and advantages of organic solar cells?
5. Explain the use of bypass and blocking diodes in PV modules.
6. Compare lead-acid and lithium-ion batteries for PV systems.
7. Write a short note on bifacial solar panels.
8. Mention any two IoT-based solar radiation sensors and their applications.

PART – B

Answer any FIVE questions. Each question carries 10 marks.

5 × 10 = 50 Marks

9. a) Describe the classification of solar energy systems with examples.

(OR)

b) Explain the construction and working of a flat plate collector with a neat diagram.

10. a) Explain the design and performance evaluation of a solar still.

(OR)

b) Describe the working principle of solar dryers. How do Phase Change Materials (PCMs) enhance their performance?

11. a) Discuss the structure and working of a photovoltaic cell. Explain the significance of I-V characteristics.

(OR)

b) Define and explain Fill Factor and Quantum Efficiency. What factors affect the efficiency of a solar cell?

12. a) Discuss various types of thin film solar cells. What are their advantages over crystalline silicon cells?

(OR)

b) Explain the fabrication steps of a solar module. How are cells connected and protected?

13. a) Explain different types of energy storage systems used in solar PV.

(OR)

b) Write short notes on:

(i) LFP and sodium-ion batteries

(ii) Smart grid and hybrid PV systems