

**SHIVAJI UNIVERSITY, KOLHAPUR**



“A” Re accredited by NAAC (2014)

with CGPA 3.16

Structure, Scheme and Syllabus for

Certificate Course

in

**“Instrumentation: Self-Cleaning Solar Cell Panels”**

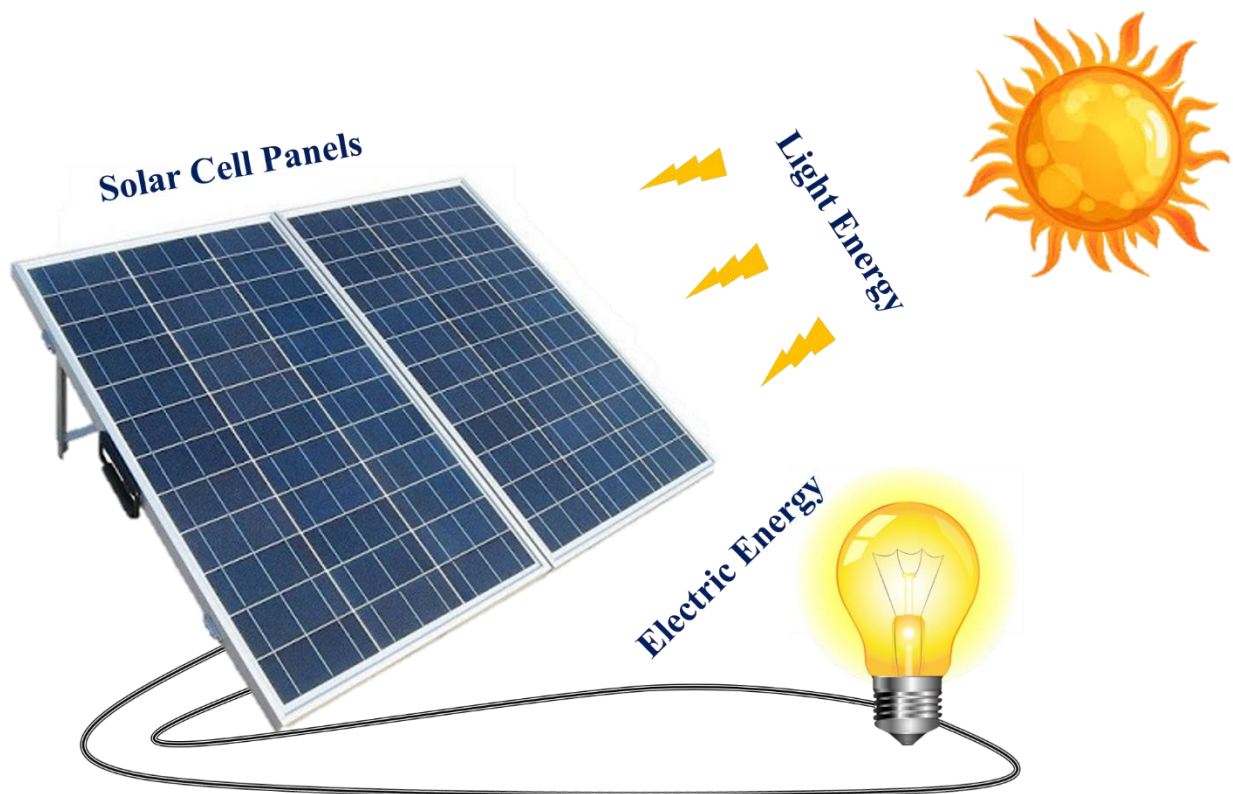
**Raje Ramrao Mahavidyalaya, Jath, Dist: Sangli**

(Subject to the modifications that will be made from time to time)

**Syllabus to be implemented from June 2020 onwards.**

## 1. COURSE INFORMATION

Light is energy. Solar energy is renewable energy which we can use again and again. Solar energy can be used in different ways for long period of time without environmental hazards. Solar energy is eco-friendly and pollution free source of energy. Solar energy does not pollute our environment after installation. It does not produce greenhouse gases like carbon dioxide and methane. A photovoltaic (PV) system is used to convert the solar light energy into electrical energy. The basic components of the PV system is known as the solar cell. A single solar cell has the capacity of producing about 0.5 volts of electricity. A solar panel or solar module is the combination of several solar cells connected in series to generate usable voltage. A combination of solar panels connected together is known as solar array and can be used to achieve required current and voltage. The generation of electricity on exposure to sunlight is known as the photovoltaic (PV) effect. This principle is used by solar cells to produce electricity (Fig. 1).



**Fig. 1:** Working of Solar Cell.

The solar cells are made up of semiconductor like silicon and comprises of three layers. The top layer is called the n-type layer which is comparatively thin and contains high concentration of electrons. The bottom layer is called the p-type layer containing high concentration of holes. When the p-type and n-type semiconductor is joined, it forms a PN junction. On forming a PN junction, the electrons of the n-type material try to reach the P region creating a negatively charged

layer. Similarly the holes of the p-type material try to reach the end region creating a positively charged layer. This region between the two layers is known as the depletion region of the semiconductor. Sunlight penetrates the top thin layer easily to reach with the position region due to the deficiency of charge in the depletion region. It contains neutral atoms. These neutral atoms are broken when the photons from the sunlight strike the depletion layer. The electrons from the neutral atoms leaving behind the holes and producing free charge carriers. Then the electrons move towards the n-type layer and the holes moves towards the p-type layer due to the electric field present in the depletion region. On connecting an electronic circuit, the electrons flow through it generating electricity to electrical devices like bulbs and etc as shown in Fig. 1. During cloudy days and nights, electric energy can be stored during the sunlight. Various developed countries are completely running on solar energy. Thus, solar energy for photovoltaic conversion into electricity is abundant, inexhaustible, and clean; yet, it also requires special techniques to gather enough of it effectively.

A mimicry of self-cleaning characteristics of lotus leaf can be made on the various solid surfaces for the rapid self-cleaning performance. The self-cleaning superhydrophobic coating can be applied on the top glass plate of solar panels by dip and spray coating methods. Though the dust, dirt, debris, and bird dropping get accumulated on these superhydrophobic solar cell panels, the adhesion between the dirt and superhydrophobic panel is very low and solar panels can be self-cleaned by simply spraying water on it. The rolling water drops can effectively collect the dust particles and take off the surface. Hence the solar cell panel surface become clean and eventually the solar cell performance get improved.

## **2. Training Scheme**

The (NSQF) under Ministry of Skill Development & Entrepreneurship offers a range of vocational training courses catering to the need of different sectors of economy/ Labour market. The vocational training programmes are delivered under the aegis of NSQF.

‘Instrumentation: Self-Cleaning Solar Cell Panels’ is one of the popular courses delivered nationwide through network of NSQF. The course is of six months duration. It mainly consists of Domain area and Core area. The Domain area (Trade Theory & Practical) imparts professional skills and knowledge, while Core area (Employability Skills) imparts requisite core skill & knowledge and life skills. After passing out the training program at every level the trainee is awarded by Certificate given by college and university which is recognized worldwide.

## **2.1 Candidates require broadly demonstrating that they are competent to:**

- a) Read and interpret technical parameters/ documents, plan and organize work processes, identify necessary materials and tools;
- b) Perform task with due consideration to safety rules, accident prevention regulations and environmental protection stipulations; Apply professional skill, knowledge & employability skills while performing jobs.
- c) Document the technical parameters related to the task undertaken.

## **2.2 Development pathways**

- a) Can become Entrepreneur in the related field.
- b) Can join as Technician and will progress further as Senior Technician, Supervisor and can rise up to the level of Manager.
- c) Can join Apprenticeship programme in different types of industries leading to National Apprenticeship certificate (NAC).
- d) Can join Master Degree (Vocational) courses under NSQF as applicable.

## **3. LEARNING OUTCOME**

**Learning outcomes are an expression of total competencies of a learner and assessment will be carried out as per the assessment criteria.**

### **3.1 LEARNING OUTCOMES (TRADE SPECIFIC)**

At the end of the course, the student is able: -

- a) To understand the role of solar energy in the context of regional and global energy system, its economic, social and environmental connotations, and the impact of technology on a local and global context.
- b) Apply fundamental concepts and circuit laws to solve simple DC electric circuits.
- c) To understand and analyses AC & DC circuits.
- d) To understand the physical principles of the photovoltaic (PV) solar cell and what are its sources of losses.
- e) To understand and apply the basic concepts of solar radiation necessary for dimensioning (sizing) PV systems installations.
- f) To know the electrical (current-voltage and power-voltage) characteristics of solar cell, panel or generator and how the environment parameters influence it .

- g) Hands-on training on instruments like solar cell panels, dip coater, spin coater, spray coater, hydrothermal unit, electrospinning unit, contact angle meter, ultrasonicator, magnetic stirrer, roughness meter, surface hardness tester etc.
- h) To know the most important characteristics of the elements within a PV system and how they work: battery and charge controller, DC/DC converter, DC/AC converter (inverter) and loads.
- i) To present a software tools for PV system engineering.
- j) Knowledge about quality control and quality assurance.
- k) To list the relevant organizations, major projects at the international level, the main sources of information and regulations related to solar photovoltaic technology.
- l) Independent handling of instrument.
- m) Production of self-cleaning superhydrophobic coating on solar cell panels.
- n) To know the main lines of research in the field of photovoltaic technology and solar energy.
- o) To bring innovative ideas in the field of solar photovoltaic energy.
- p) On developing business on solar cell, uneducated labour can get employment.
- q) Data validation, method validation, documentation and audit knowledge.
- r) Job placement in various industrial sectors as mentioned above.

**Key Features: Objectives**

- a) To provide judicious mix of skills relating to a profession and appropriate content of General Education.
- b) To ensure that the students have adequate knowledge and skills, so that they are work ready at each exit point of the programme.
- c) To provide flexibility to the students by means of pre-defined entry and multiple exit points.
- d) To integrate NSQF within the undergraduate level of higher education to enhance employability of the students and meet industry requirements. Such student apart from meeting the needs of local and national industry are also expected to be equipped to become part of the global workforce.
- e) To provide vertical mobility to students admitted in such vocational courses.

The certification levels will lead to Diploma/Advanced Diploma/B. Voc. Degree in Industrial Tool Manufacturing and will be offered by respective affiliating University. Students may be awarded Level Certificate/Diploma/Advance Diploma /Degree as out-lined in the Table below:

## Course Structure

The course will consist of combination of practical's, theory and hands on skills in the Capital Goods Sector.

Award	Duration after class XII	Corresponding NSQF level
Certificate	Sixth month	5
Diploma	1 Year	6
Advance Diploma	2 Year	7
B.Voc. Degree	3 Year	8

## Curriculum

The curriculum in the programme would be a suitable mix of general education and skill development components.

### Skill Development Components:

- a) The focus of skill development components shall be to equip students with appropriate knowledge, practice and attitude, to become work ready. The skill development components will be relevant to the industry as per its requirements.
- b) The curriculum will necessarily embed within itself, National Occupational Standards (NOSs) of specific job roles within the industry. This would enable the students to meet the learning outcomes specified in the NOSs. The overall design of the skill development component along with the job roles selected will be such that it leads to a comprehensive specialization in few domains.
- c) The curriculum will focus on work-readiness skills in each of the year of training.
- d) Adequate attention will be given in curriculum design to practical work, on the job training, development of student portfolios and project work, Industrial Tool Manufacturing.

### A] Ordinance and Regulations: (As applicable to Degree Vocational Course)

### B] Shivaji University, Kolhapur

Syllabus for Certificate course in 'Solar Photovoltaic Module Manufacturing, Installation and Maintenance'.

- 1) **TITLE:** "Instrumentation: Self-Cleaning Solar Cell Panels" under the Faculty of science.

2) **YEAR OF IMPLEMENTATION:** - Syllabi will be implemented from June 2020 onwards.

3) **PREAMBLE:** -[Note :-The Adhoc Board of Studies should briefly mention foundation, core and applied components of the course/paper. The student should get into the prime objectives and expected level of study with required outcome in terms of basic and advance knowledge at examination level.]

4) **DURATION** Certificate Course (Six months)

5) **STRUCTURE OF COURSE:**

- a) Two general papers
- b) Three Core Course papers
- c) Five practical papers
- d) One Project / Industry Visit/ Study Tour / Survey/Internship/Hands-on training

6) **SCHEME OF EXAMINATION**

**A. Theory Examination**—as per Shivaji University rules.

- a) The examination shall be conducted at the end of course.
- b) The Theory paper shall carry 50 marks.
- c) The evaluation of the performance of the students in theory papers shall be on the basis of Examination of 50 marks.
- d) Question Paper will be set in the view of the /in accordance with the entire syllabus and preferably covering each unit of syllabi.

**B. Practical Examination:** There will be external practical examination attendant to course.

**A) THEORY**

The theory examination shall be at the end of the certificate course. All the general theory papers shall carry 40 marks and all theory papers shall carry 50 marks. Evaluation of the performance of the students in theory shall be on the basis of examination as mentioned above. Question paper will be set in the view of entire syllabus preferably covering each unit of the syllabus.

**Nature of question paper for Theory examination** (Excluding Business Communication Paper)–

Q.1 Multiple choice	10 Marks
Q.2 Long answer type (any two) out of three	20 Marks
Q.3 Write short notes (any four) out of six	20 Marks

**B) PRACTICAL**

Evaluation of the performance of the students in practical shall be on the basis of examination

General Paper 1	10 Marks
General Paper 2	10 Marks
Each core course having separate practical	50 Marks

**C) Project /field visit/ internship/fieldwork/Hands on training** 50 Marks

**7) FEE STRUCTURE:**

As per Government / University rules.

- a) Refer website of concern affiliated college/institute to Shivaji University, Kolhapur.
- b) Other fee will be applicable as per rules and norms of UGC and Shivaji University, Kolhapur.

**8) ELIGIBILITY FOR ADMISSION:**

As per guidelines obtained from UGC, NSQF and Shivaji University, Kolhapur by following rules and regarding reservations by Govt. of Maharashtra.

**9) MEDIUM OF INSTRUCTION:** The medium of instruction shall be in English.

**10) STRUCTURE OF COURSE-** Certificate course in “Instrumentation: Self-Cleaning Solar Cell Panels”

**11) Eligibility for Admission :** 10 + 2 from science faculty.

**12) Eligibility for Faculty:**

- 1) M. Sc. Physics with NET/SET/ Ph.D.
- 2) M.A. (English) with NET/SET for Communication, Presentation & Management Skills



**SHIVAJI UNIVERSITY, KOLHAPUR**  
**RAJE RAMRAO MAHAVIDYALAYA, JATH, DIST: SANGLI**  
**STRUCTURE AND SYLLABUS OF CERTIFICATE COURSE**

**“Instrumentation: Self-Cleaning Solar Cell Panels”**

**Credits: 30**

Course Code	Courses Title	Distribution of Marks			Credits			
		T	P	Project /Field Visit/ Internship/ Field work	T	P	Project/ Field Visit/ Internship/ Field work	Total
CPMS – 101	Communication, Presentation & Management Skills – I	40	10		03	02		<b>05</b>
CPMS – 102	Communication, Presentation & Management Skills – II	40	10		03	01		<b>04</b>
ISSCP-103	Physics of Photovoltaic Systems	50	50		03	03		<b>06</b>
ISSCP-104	Fundamentals of Thin Films and Coatings	50	50		03	04		<b>07</b>
ISSCP-105	Self-Cleaning Solar Cell Cover Glasses	50	50		03	04		<b>07</b>
	Project/Field visit/Internship /Field work/Hands on training			50			01	<b>01</b>
<b>Total</b>		<b>230</b>	<b>170</b>	<b>50</b>	<b>15</b>	<b>14</b>	<b>01</b>	<b>30</b>
<b>Total</b>		<b>450</b>						

**SHIVAJI UNIVERSITY, KOLHAPUR**  
**RAJE RAMRAO MAHAVIDYALAYA, JATH, DIST: SANGLI**

**Certificate Course**

**“Instrumentation: Self-Cleaning Solar Cell Panels”**

**Course Code. CPMS – 101**

**COMMUNICATION, PRESENTATION AND MANAGEMENT SKILLS – I**

**Course Content: Theory**

**Unit I: Communication Skill**

**22 Hrs**

Meaning and Definition of communication, Process of communication, Types of communication (verbal and non-verbal), Importance of communication, Different forms of communication, Barriers to communication, Group discussion, Interview, Extempore, Business negotiation, Public speaking, Meeting, Toasting, Counselling, Business presentation, Oral Presentation.

**Unit II: Writing Skill**

**10 Hrs**

C.V., Writing Cover letters, Formal Letter- Official/Business, Report writing, Information Transfer from Graphs, Charts etc Dialogue/Monologue, Describing objects, events & process, Designing pamphlets & Brochure, Writing E-mails, SMS, Short-notes.

**Unit III: Business Etiquette**

**12 Hrs**

Meaning & Definition of etiquette, Impact of etiquette, Effects of Business etiquette, Importance of Business etiquette, Different types of Business etiquette-Telephone etiquette, Dining etiquette, Office etiquette, Meeting etiquette, Netiquettes (Email, Chatting etiquette)

**Reference Books:**

1. Robert T. Reilly–Effective communication in tourist travel Industry Dilnas Publication.
2. Boves. Thill Business Communication Today Mcycans Hills Publication.
3. Dark Studying International Communication Sage Publication.
4. L. Garteside (ELBS) Modern Business Letters.
5. R. K. Madhukar, Business Communication, Vikas Publishing House Pvt. Ltd., Noida.
6. Herekar, Praksh. *Business Communication*. Pune: Mehta Publications, 2007.
7. John, David. *Group Discussions*. New Delhi: Arihant Publications.
8. Pradhan, N. S. *Business Communication*. Mumbai: Himalaya Publishing House, 2005
9. Whitehead, Jeffrey & David H. Whitehead. *Business Correspondence*. Allahabad: Wheeler Publishing, 1996.

**SHIVAJI UNIVERSITY, KOLHAPUR**  
**RAJE RAMRAO MAHAVIDYALAYA, JATH, DIST: SANGLI**

**Certificate Course**

**“Instrumentation: Self-Cleaning Solar Cell Panels”**

**Course Code. CPMS – 102**

**COMMUNICATION, PRESENTATION AND MANAGEMENT SKILLS – II**

**Course Content: Theory**

**Unit I: Business Correspondence**

**12 Hrs**

Drafting Memos, Writing formal and informal e-mails, Writing letter of inquiry and complaints, Letter of Placing Orders and Tenders.

**Unit II: English for Negotiation and Marketing**

**20 Hrs**

Business Negotiations, What is business negotiation, Agenda for Negotiation, Stages of Negotiation, Describing/Explaining a Product/Service, Promotion of a Product, Dealing/bargaining with Customers, Marketing a Product/Service: Use of Pamphlets, Hoardings, Advertisement.

**Unit III: Group Discussion**

**12 Hrs**

Dos and Don'ts, Preparing for a Group Discussion, Initiating a Discussion, Eliciting Opinions, Views, etc., Expressing Agreement/Disagreement, Making Suggestions; Accepting and Denying Suggestions, Summing up.

**Reference Books:**

1. Matila Treece: Successful communication: Allyunand Bacon Pubharkat.
2. Jon Lisa Interatid skills in Tourist Travel Industry Longman Group Ltd.
3. Boves. Thill Business Communication Today Mcycans Hills Publication.
4. Murphy Hidderandt Thomas Effective Business Communication Mc GrawHill.
5. L. Garteside (ELBS) Modern Business Letters.
6. Pradhan, Bhende and Thakur– Business Communication, Himalaya Publishing House
7. R. K. Madhukar, Business Communication, Vikas Publishing House Pvt. Ltd., Noida.
8. U. S. Rai & M. S. Rai, Business Communication, Himalaya Publishing House, Bombay
9. Herekar, Praksh. *Principals of Business Communication*. Pune: Mehta Publications, 2003
10. John, David. *Group Discussions*. New Delhi: Arihant Publications.
11. Pradhan, N. S. *Business Communication*. Mumbai: Himalaya Publishing House, 2005

**SHIVAJI UNIVERSITY, KOLHAPUR**  
**RAJE RAMRAO MAHAVIDYALAYA, JATH, DIST: SANGLI**

**Certificate Course**

**“Instrumentation: Self-Cleaning Solar Cell Panels”**

**Course Code: ISSCP-103**

**PHYSICS OF PHOTOVOLTAIC SYSTEMS**

**Course Content: Theory**

**Unit I: Energy and its Sources**

**11 Hrs**

Energy, Sources of energy: conventional and non-conventional energy sources, main sources of power generation/electricity: Thermal power, Hydro-electric power and nuclear power, Environmental Impacts of fossil fuels, greenhouse effect, non-conventional sources: wind energy, Bio energy, Tidal energy, Geothermal energy and Solar energy, need of Sustainable energy sources.

**Unit II: Band Theory in Semiconductor Physics**

**22 Hrs**

Band formation in materials, Classification of materials on the basis of band theory: insulator, conductor and semiconductor, Types of semiconductor on the basis of doping: Intrinsic and Extrinsic semiconductor, N-type and P-type semiconductor, types of semiconductor on the basis of band gap: Direct and indirect band gap, concept of current density and mobility for an intrinsic semiconductor, IV characteristics of PN junction diode in forward and reverse bias mode.

**Unit III: Principle of Solar Energy Conversion**

**12 Hrs**

Solar radiation and spectrum, principal of solar energy conversion, Photovoltaic effect, working principle of solar cell, concept of diffusion length, diffusion coefficient, absorption length, I-V characteristics, I-V equation and operating point of solar cell, Equivalent model of solar cell, fill factor and efficiency of solar cell, factors affecting on efficiency such as temperature, solar radiation, effect of series and shunt resistance, losses in solar cell.

**Reference books:**

1. Solar photovoltaic: fundamentals, technologies and applications by Chetan Singh Solanki.
2. Introduction of Solid-state physics by Charles Kittel.
3. Optoelectronics and Photonics by S.O. Kasap.

**SHIVAJI UNIVERSITY, KOLHAPUR**  
**RAJE RAMRAO MAHAVIDYALAYA, JATH, DIST: SANGLI**

**Certificate Course**

**“Instrumentation: Self-Cleaning Solar Cell Panels”**

**Course Code: ISSCP-104**

**FUNDAMENTALS OF THIN FILMS AND COATINGS**

**Course Content: Theory**

**Unit I: Basics of Thin Films/Coatings**

**06 Hrs**

Definition of thin films and coatings, Basics of Thin films and Nanostructures, Role of thin films in Devices.

**Unit II: Fabrication of Thin Films/Coatings**

**16 Hrs**

Sol-gel Synthesis, Spin coating, Spray coating, Dip coating, Chemical vapor deposition, Physical vapor deposition, Sputtering deposition, ion implantation, Cathodic arc deposition, Pulsed laser deposition, Molecular beam epitaxy.

**Unit III: Characterization of Thin Films/Coatings**

**11 Hrs**

Scanning Electron Microscopy, X-ray diffraction, UV-VIS spectroscopy, Four probe resistivity, Atomic probe microscopy, Surface Profilometer, Transmission Electron Microscopy.

**Unit IV: Properties and Applications of Thin Films**

**12 Hrs**

Structural, electrical, magnetic, optical, thermal, etc., Application of thin films/coatings in different areas such as electronics, medical, defence, sports, automobiles, etc.

**Reference books:**

1. G. Cao, “Nanostructures & Nanomaterials: Synthesis, Properties & Applications”, Imperial College Press, 2004.
2. W.T.S. Huck, “Nanoscale Assembly: Chemical Techniques (Nanostructure Sci. & Tech.)”.
3. Thin Film Phenomena by K. L. Chopra, McGraw Hill 1969.

**SHIVAJI UNIVERSITY, KOLHAPUR**  
**RAJE RAMRAO MAHAVIDYALAYA, JATH, DIST: SANGLI**

**Certificate Course**

**“Instrumentation: Self-Cleaning Solar Cell Panels”**

**Course Code: ISSCP-105**

**SELF-CLEANING SOLAR CELL COVER GLASSES**

**Course Content: Theory**

**Unit I: Wetting Properties of Solids** **15 Hrs**

Wetting properties of solids: hydrophilic, hydrophobic, superhydrophobic, Youngs Model, Wenzels Model, Cassie-Baxters Model, Introduction to superhydrophobic surfaces, Lotus effect: superhydrophobic self-cleaning effect.

**Unit II: Synthesis and Deposition of Hydrophobic Silica Nanoparticles** **15 Hrs**

Synthesis of hydrophobic silica nanoparticles, Effect of sol-gel parameters on the size of silica nanoparticles, Deposition of superhydrophobic coating using dip, spin, and spray deposition techniques.

**Unit III: Characterization of Self-Cleaning Solar Cell Cover Glasses** **15 Hrs**

Evaluation of performance of solar cell after applying self-cleaning superhydrophobic cover glasses, Water contact angle and sliding angle measurements, Effect of surface roughness on optical transparency of the coating, Efficiency in dust repellence, advantages and disadvantages of the coatings.

**Reference books:**

1. Self-cleaning Coatings. Structure, Fabrication and Application- Junhui He
2. Wetting of Real Surfaces- Edward Yu. Bormashenko
3. Surfaces and Interfaces of Biomimetic Superhydrophobic Materials- Z. Guo,& F. Yang
4. Surface Characterization- D. Brune, R. Hellborg & H. J. Whitlow, O. Hunderi



**SHIVAJI UNIVERSITY, KOLHAPUR**  
**RAJE RAMRAO MAHAVIDYALAYA, JATH, DIST: SANGLI**

**Certificate Course**

**“Instrumentation: Self-Cleaning Solar Cell Panels”**

**Course Code. Course Code: ISSCP-103**

**Practical III**

**PHYSICS OF PHOTOVOLTAIC SYSTEMS**

**Credit: 03**

**Practical: 5 Lectures/week/batch**

**Practical: 50 Marks**

**List of Experiments**

1. Identify various types of cables and measure conductor size using SWG and micrometer.
2. Practice in crimping and soldering of joints / lugs
3. Use of various analog and digital measuring Instruments.
4. Measure current and voltage in DC circuits to verify Kirchhoff's Law.
5. To verify Thevenin's theorem
6. To verify Norton's Theorem
7. Verify the characteristics of series parallel combination of resistors.
8. Identify various types of capacitors, charging /discharging and testing with time constant.
9. Test AC circuit with resistive load like lamp, heater, etc.
10. Measure power, energy for lagging and leading power factors in single phase circuits.

**Reference Books**

1. V. N. Mittal and Arvind Mittal “Basic Electrical Engineering” McGraw Hill.
2. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
3. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
4. D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.
5. Electricity and Magnetism – Khare and Shrivastav.
6. Foundations of Electromagnetic Theory – Rritz and Milford.
7. Concepts of Physics Vol-2 H. C. Verma



**SHIVAJI UNIVERSITY, KOLHAPUR**  
**RAJE RAMRAO MAHAVIDYALAYA, JATH, DIST: SANGLI**

**Certificate Course**

**“Instrumentation: Self-Cleaning Solar Cell Panels”**

**Course No. ISSCP-104**

**Practical IV**

**FUNDAMENTALS OF THIN FILMS AND COATINGS**

**Credit: 04**

**Practical: 5 Lectures/week/batch**

**Practical: 50 Marks**

**List of Experiments**

1. I/V Characteristics of Solar Cell
2. Detailed Use of Magnetic Stirrer
3. Detailed Use of Ultrasonic Cleaner
4. Preparation of Superhydrophobic Coating by Dip Coat Technique
5. Preparation of Superhydrophobic Coating by Spin Coat Technique
6. Preparation of Superhydrophobic Coating by Spray Coat Technique
7. Surface Roughness Measurement using Portable Surface Hardness Tester.
8. Static Water Contact Angle Measurement using Goniometer
9. Dynamic Water Sliding Angle Measurement using Goniometer
10. Analysis of Optical Transparency by UV-VIS Spectrophotometer

**Reference books:**

1. G. Cao, “Nanostructures & Nanomaterials: Synthesis, Properties & Applications”, Imperial College Press, 2004.
2. W.T.S. Huck, “Nanoscale Assembly: Chemical Techniques (Nanostructure Sci. & Tech.)”.
3. Thin Film Phenomena by K. L. Chopra, McGraw Hill 1969.

**SHIVAJI UNIVERSITY, KOLHAPUR**  
**RAJE RAMRAO MAHAVIDYALAYA, JATH, DIST: SANGLI**

**Certificate Course**

**“Instrumentation: Self-Cleaning Solar Cell Panels”**

**Course No. ISSCP-105**

**Practical V**

**SELF-CLEANING SOLAR CELL COVER GLASSES**

**Credit: 04**

**Practical: 5 Lectures/week/batch**

**Practical: 50 Marks**

**List of Experiments**

1. Synthesis of Silica Nanoparticles by Sol-Gel Method
2. Effect of Water drop impact test on Coating
3. Effect of Water jet impact test on Coating
4. Effect of UV illumination on Coating
5. Effect of different pH liquids on Coating
6. Sandpaper Abrasion Test
7. Pencil Hardness Test
8. Self-Cleaning Performance using Dust Particles
9. Self-Cleaning Performance using Muddy Water
10. To analyse the performance of Solar Cell after fitting Superhydrophobic Cover Glass.

**Reference books:**

1. Self-cleaning Coatings. Structure, Fabrication and Application- Junhui He
2. Wetting of Real Surfaces- Edward Yu. Bormashenko
3. Surfaces and Interfaces of Biomimetic Superhydrophobic Materials- Z. Guo,& F. Yang
4. Surface Characterization- D. Brune, R. Hellborg & H. J. Whitlow, O. Hunderi

We are herewith submitting the Structure, Scheme and Syllabus for Certificate Course in “Instrumentation: Self-Cleaning Solar Cell Panels” sanctioned by National Skills Qualifications Framework (NSQF) to the Raje Ramrao Mahavidyalaya (RRM) Jath, Dist: Sangli, Maharashtra, India.

**Coordinator**  
Dr. S. S. Latthe

**HOD, Physics**  
Dr. S. R. Kokare

**Principal**  
Dr. A. K. Bhosale