SAVITRIBAI PHULE PUNE UNIVERSITY
(Formerly University of Pune)

Revised Syllabus for

Certificate Course in Design of Solar Photovoltaic Systems

from Academic Year 2022-23 onwards

FACULTY: FACULTY OF SCIENCE AND TECHNOLOGY
BOARD: ENERGY TECHNOLOGY

Centre for Energy Studies
Savitribai Phule Pune University
Pune 411 007

July 2022

Savitribai Phule Pune University,
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Syllabus for Certificate Course in Design of Solar Photovoltaic Systems

[Total 60 contact hours = 40 lectures + 20 practical, tutorials and assignments]

Unit 01- Solar Scenario and Available Technologies [0.5 credit]

Overview of Global Scenario in Renewable Energy, National Action Plan on Climate Change, Jawaharlal Nehru National Solar Mission, State wise Initiatives, Policy Framework Support in India for RE, Exemption from Taxes, Current Status of SPV Industry, Renewable Purchase Obligation, present status in various States, Future possibilities due to RPO, Solar Energy- Principles & Technology, Concepts of Solar PV, Introduction to Solar Energy, Irradiance, Solar Window & tilt angle, Atmospheric effects ,Diffused radiation, Solar air mass, sensitivity of PV materials to various wavelengths, Cell efficiency and fill factor , Response to temperature ,irradiation, Materials used for Solar PV, Latest development of technologies in Solar PV, future trends in solar cell technology, Instruction to components of a solar photovoltaics systems: modules, array, inverters, balance-of-system components, safety devices etc.

Unit 02: Designing of Solar Photovoltaic System [0.5 credit]

Classification of solar PV systems types as off-grid, grid-tie, and hybrid solar PV systems. Designing of Solar Photovoltaic system depending on the type of system.

Unit 03: Off-Grid Systems [0.5 credit]

Solar PV Off-Grid systems - Introduction, Importance of off-grid systems, Components of an off-grid system, Types of off-grid system, Design consideration , check list for site investigation, Applications, limitations. Case study in Off-Grid system- Students will practice a case study of off grid system design. Case study of Off-grid system with the help of Arbutus developed software ‘Arkasys’.

- Power Plant
- Water Pumping System

Solar PV Off-Grid System (Power plant and Water Pumping) – Financial calculations and costing, Project summary, possible incentives from GOI, Project Cost breakup, Financial Analysis and IRR(Internal rate of return).

Unit 04: Grid Connected Systems [0.5 credit]

Solar PV Grid-connect Systems- Definition of grid connected system, advantages of grid connected systems. Peculiarity of grid systems- Rules, regulations, statutory requirements.

Site investigation- assessment of site, suitability, factors for selection of site, assessment of land requirement . Resource assessment- Solar Resource Assessment, Software for metereological data- NASA, Meteonorm, IMD .

Selection of module technology – Crystalline and Thin film technologies, comparative advantages and disadvantages, technical characteritics. Components in Grid connected SPV Plant- Module, Junction Boxes, String Monitoring Units, Mounting structures, Interconnection Cables, Inverters, transformers, power evacuation arrangements, Metering Scheme. Design – Software Tools for PV Design, Assessment of annual energy generation, Design of PV Array, Shadow analysis of different shadow causing structures. Detailed DC Engineering -DC Cable Sizing Calculations, DC Cable Voltage drop calculations Plant DC Cable Schedule preparation, developing DC Single line diagram (SLD).

Overview of layout of SPV plant using Auto Cad, developing different detailed drawings of plant design, Plant array layout, Position of Junction Boxes, SMUs, Trench layout. Practice by students in Auto Cad for above drgs on live project. Earthing and Lightning Arrestor Design. Development of Bill of quantities(BoQ)- How to prepare a BoQ, Basic assumptions and accuracy. Preparation of a bankable DPR- Structure of DPR, major topics to be covered, Financial importance. Grid Connected System Financials- Evaluation of cost of a project, Project summary, Project Cost breakup, Financials, Sensitivity Analysis, Preparation of levelised cost sheet.

Unit 05: Experiments [1 credit]

1. Ecosense – PV Simulator (9 experiments)
Performance of SPV module:
a. Current-voltage characteristic curve (I-V Curve) construction
b. Physical properties of solar module and temperature dependence
c. I-V and P-V characteristics with series and parallel combination of modules
2. Effect of direct and diffuse radiation on crystalline and thin film modules
3. Assemble and dismantle of solar lanterns
4. Solar water pump system (Day (water pump) + Night (Home lighting))
5. Understanding of various parts of the inverter (non-working)
6. Tools and accessories used in solar PV systems and power plants

Unit 06: Group Discussion- On a chosen topic [0.5 credits]

Unit 07: Entrepreneur Awareness [0.5 credit]

Mode of Examination: 3 hours Written test to verify the assimilation of knowledge to candidate and to assess the level of understanding.

Recommended books:

1. Roger A Messenger and Jerry Ventre, “Photovoltaic Systems Engineering” Second Edition, CRC Press, Taylor & Francis Group, 2004.
2. Antonio Luque, Steven Hegedus, “Handbook of Photovoltaic Science and Engineering” John Wiley & Sons, 2011 .
3. Stuart R. Wenham, “Applied Photovoltaics” , Earthscan, 2007 .
4. Falk Antony, Christian Dürschner, Karl-Heinz Remmers, “Photovoltaics for professionals: solar electric systems marketing, design and installation”, Earthscan Solarpraxis AG, 2007.
5. Mary D. Archer, Robert Hill, “Clean Electricity from Photovoltaics”, Imperial College Press, 2001

6. Chetan Singh Solanki, “Solar photovoltaics : fundamentals, technologies and applications” 2nd ed, PHI Learning New Delhi, 2011.

Learning Outcomes:

After completing this course, student should be able to:

1) Demonstrate knowledge of and apply key solar electric system terms and concepts.
2) Size and design a photovoltaic system.
3) Mount, ground, position, install, wire and connect a photovoltaic system.
4) Test voltage generated by photovoltaic system Operate & Maintain of Solar Power.
5) Participants will learn different types of solar PV module and batteries used in solar PV plant.
6) Design of solar PV Plant based on estimated loads.

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