PIPM 7005	Solar Power Development and Management	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Graduate in Engineering/Science discipline				
Co-requisites	Basic understanding about power sector				

Course Objectives

1. To facilitate the students to achieve a clear conceptual understanding of technical and commercial aspects of Solar Power Development and Management.
2. To enable the students to develop managerial skills to assess feasibility of alternative approaches and drive strategies regarding Solar Power Development and Management.

Course Outcomes

On completion of this course, the students will be able to exhibit

CO1. Conceptual knowledge of the technology, economics and regulation related issues associated with solar power development and management

CO2. Ability to analyse the viability of solar power projects

CO3. Capability to integrate various options and assess the business and policy environment regarding solar power projects

CO4. Advocacy of strategic and policy recommendations on usage of solar power

Catalog Description

Worldwide, increased focus on sustainable development has led to sharp rise in development of solar power projects. As solar power is a clean and renewable energy option, countries are promoting its large-scale usage wherever possible. Technology improvements, mass manufacturing and innovative financing mechanisms have made solar power achieve grid parity in many countries. Thus, with reduced solar power prices and dependable electricity storage options, large-scale integration of solar power to the grid has been planned. This has opened up numerous job opportunities worldwide. In this course, students will be engaged to help them acquire technical and commercial knowledge and skills associated with solar power development and management. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies, such as group discussions, cooperative group solving problems, quizzes, presentations, etc. Class participation is a fundamental aspect of this course. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, YouTube videos, blogs, and newspapers articles.

Course Content

Unit I: 9.0 lecture hours

Introduction; Global trend in solar energy; Solar energy – source of energy, quantum of energy, irradiance; Type of radiation – beam, diffuse, total; Solar technology – solar PV, solar thermal; Solar resource availability in India – opportunities and challenges

Unit II: 9.0 lecture hours

Solar PV power systems – roof top system, solar power plant; Solar PV power plant layout and working principle; Solar PV power economics; Global solar PV power trend

Unit III: 9.0 lecture hours

Solar thermal system – solar thermal power plant (parabolic and solar tower); Solar thermal power plant layout and working principle; Solar thermal power economics; Solar thermal power economics; Global solar thermal power trend

Unit IV: 9.0 lecture hours

Comparison between solar PV power projects and solar thermal power projects; Issues of intermittency, storage and grid integration; solar power policies – World and India (RPO, REC); Solar Parks; Financing solar power projects

Text Books

1. Winter C.J., Sizmann R.L., Vant-Hull L.L. (1991). Solar Power Plants: Fundamentals, Technology, Systems, Economics. Springer. ISBN: 3540188975.
2. Jordan P.G. (2013). Solar Energy Markets: An Analysis of the Global Solar Industry. Academic Press. ISBN: 0123977681.

Reference Books

1. Islam M.R., Rahman F., Xu W. (2016). Advances in Solar Photovoltaic Power Plants. Springer. ISBN: 3662505193.
2. Sukhatme S.P. (2008). Solar Energy: Principles of Thermal Collection and Storage. Tata McGraw-Hill Education. ISBN: 0070260648.

Modes of Evaluation (100 Marks)

Quiz: 20 marks
Assignment/Presentation: 30 marks
Written Exam (End-semester): 50 marks

Examination Scheme

Components	Internal Assessment (Quiz/Assignment/Presentation/Extempore)	End-Semester Exam (Written Exam)
Weightage (%)	50%	50%

Relationship between the Course Outcomes (COs) and Program Outcomes (POs/PSOs)

Mapping between COs and POs		
	Course Outcomes	**Mapped Programme Outcomes**
CO1	Conceptual knowledge of the technology, economics and regulation related issues associated with solar power development and management	**PO1, PO8, PSO1, PSO2**
CO2	Ability to analyse the viability of solar power projects	**PO2, PSO3, PSO5**
CO3	Capability to integrate various options and assess the business and policy environment regarding solar power projects	**PO3, PSO4, PSO5**
CO4	Advocacy of strategic and policy recommendations on usage of solar power	**PO4, PO6, PO8 , PSO4, PSO5**

Program Outcome / Course Outcome Mapping

Course Outcomes	**CO 1**	**CO 2**	**CO 3**	**CO 4**
PO 1	3	2	2	1
PO 2	1	3	2	2
PO 3	2	2	3	2
PO 4	2	2	2	3
PO 5	1	1	1	1
PO 6	2	1	2	3
PO 7	1	1	1	1
PO 8	3	1	2	3
PSO 1	3	2	1	2
PSO 2	3	2	2	2
PSO 3	1	3	2	2
PSO 4	2	3	2	3
PSO 5	3	2	3	3

Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5
PIPM 7005	Solar Power Development	3	2	3	1	1	2	1	3	3	3	3	3	3

	and Management													

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	UPES

Course: PIPM 7005 – Solar Power Development and Management
Programme: MBA (Power Management) **Semester: EVEN-2016-17**
Time: 03 hrs. **Max. Marks: 100**

Section A (Answer all questions) (5 marks * 10 = 50 marks)

1. State True or False for the following statements and justify your stand. All the questions in this section carry 5 marks each, out of which, 1 mark is for correctly stating True or False and 4 marks for justification.

a.	Concentrating solar collector can utilize all types of solar radiation.	**[5]**	**CO1**
b.	The efficiency of solar PV panel remains constant throughout its useful life.	**[5]**	**CO1**
c.	Peak watt (W_p) concept is used to rate PV panels.	**[5]**	**CO1**
d.	From electricity supply perspective, 1 MW solar power and 1 MW coal power are same.	**[5]**	**CO3**
e.	Under no circumstances, solar thermal power can be used as base load power.	**[5]**	**CO3**
f.	For large-scale implementation of solar rooftop scheme, smart-grid is a necessity.	**[5]**	**CO2**
g.	Operation and maintenance is easy for all types of solar power projects.	**[5]**	**CO2**
h.	Grid power is essential for the export of power from solar PV power plant to the grid.	**[5]**	**CO2**
i.	Concentrating solar power plants don't have large scale water requirements.	**[5]**	**CO1**
j.	CUF of solar thermal power plants is generally higher than that of solar PV power plants.	**[5]**	**CO2**
	Section B (Answer any three questions) (10 marks *3 = 30 marks)		
2.	Considering the challenges and opportunities associated with solar power, forecast the role of solar power in India's power generation mix.	**[10]**	**CO1, CO2, CO3. CO4**
3.	During last few years, solar power tariffs have been consistently falling in India. Discuss three main reasons for such a trend.	**[10]**	**CO1, CO2**
4.	In the estimation of solar power tariff, principal component of loan is not included directly but it is indirectly accounted in the tariff. Explain	**[10]**	**CO1, CO2**
5.	Briefly explain the regulatory framework with respect to roof top solar PV installations indicating various limits on power fed to the grid and benefits to the stakeholders.	**[10]**	**CO1, CO2**
	Section C (Answer any one question) (20 marks * 1 = 20 marks)		

6.	The following are the values of parameters associated with a solar PV power project: a) Installed capacity = 1 MW b) Auxiliary consumption = 0 % c) CUF = 19.0 % d) Useful life = 25 years e) Capital cost = Rs 530.02 lacs / MW f) Tariff period = 25 years g) Debt (Loan) = 70 % h) Equity = 30 % i) Moratorium period = 0 years j) Repayment period (including moratorium) = 12 years k) Interest rate on loan = 12.76 % l) Return on equity for first 10 years = 20.00 % per annum m) Return on equity 11^{th} year onwards = 24.00 % per annum n) Discount rate = 10.70 % o) Depreciation rate for first 12 years = 5.83 % p) Depreciation rate 13^{th} year onwards = 1.54 % q) O & M charges (for working capital) = 1 month's O & M expenses r) Maintenance spare (for working capital) = 15% of annual O & M expenses s) Receivables (for working capital) = Rs 19.64 lacs (equivalent to two months revenue) t) Interest on working capital = 13.26 % u) Annual O & M expenses = Rs 7.00 lacs v) O & M expenses escalation = 5.72 % With the given values and procedure prescribed by CERC, estimate the **Cost of Generation per Unit** for the **First Year of Tariff Period.** Step-wise marking will be followed for this numerical.	**[20]**	**CO1, CO2**
7.	Explain the procedure to estimate solar power potential in a state. Also, based on the electrical load and duty cycle of a household, discuss the procedure to estimate the rated capacity of PV panel to be installed at the roof top.	**[20]**	**CO1, CO2, CO3, CO4**