Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2024

Course: BBA GES **Semester: III**

Program: Solar Energy Resource Management **Time: 03 hrs.**

Course Code: OGET2003 **Max. Marks: 100**

Instructions:

SECTION A

10Qx2M=20Marks (Answer All Question)

S. No.		Marks	CO
Q 1	In which form solar resource came to earth surface	**2**	**CO1**
Q 2	What is Irradiance and its unit	**2**	**CO1**
Q 3	What are solar resource measurement techniques	**2**	**CO1**
Q 4	Name the device used to measure solar radiation	**2**	**CO1**
Q 5	Name three applications of solar energy	**2**	**CO1**
Q 6	What are standard conditions at which a solar plant works at its peak power output	**2**	**CO1**
Q 7	What is Capacity Utilization Factor (CUF)	**2**	**CO1**
Q 8	Define diffuse radiation	**2**	**CO1**
Q 9	Define Levelized cost of Electricity Generation	**2**	**CO1**
Q 10	Solar project named "A" has IRR of 12% and Solar Project "B" has IRR of 14%. The applicable discount rate for these projects was 10%. Which project would be financially viable and why	**2**	**CO1**

SECTION B

4Qx5M= 20 Marks

Q 1	A solar plant of capacity 10 MWp has been installed at the location of Dehradun in India. Plant has CUF of 17% for six months (Jan to June) and 20% for next six months (July to December). Estimate the Annual Energy Generation of the plant.	**5**	**CO2**
Q 2	Draw the schematic of a typical Utility scale solar power plant and mention the purpose of each component	**5**	**CO2**
Q 3	A location receiving 1778 kWh/m^2 of Insolation annually. A solar plant with a module area of 12000 m^2 is installed at this location. The efficiency of solar module is 16% and efficiency of inverter is 95%. Estimate the annual energy generation of the plant	**5**	**CO2**

Q 4	Define the indicators that could be well used to assess the financial attractiveness of an investment in a Solar Project	**5**	**CO2**
	SECTION-C **3Qx10M=30 Marks**		
Q 1	What are the steps involved in the Techno-commercial assessment of a Rooftop Solar System at UPES Kandoli Campus	**10**	**CO3**
Q 2	Estimate the **Unit cost of Energy Generation** for first year operation of the project of a Solar Plant located at Dehradun. Consider the following parameters. **Capacity of Plant - 05 MW**, **CUF,** 0.21, **Capital Investment** – 4 crore/MW. **O&M Cost** - 3% of Capital Cost. **Discount rate** – 10%. **Useful life of Project** – 30 years $$UCOE = \frac{ACC + CO\&M\ Cost)]}{AEG \times (1+d)^{\wedge}n}$$ ***CRF - [d(1 + d)^n /(1 + d)^n−1]***	**10**	**CO3**
Q 3	A startup formed by BBA GES students named **“Hari Urja Pvt Ltd”** got a consultancy assignment to design a hot water system for a dairy industry located in Dehradun having following requirements Mass flow rate of water – 300 kg/h, Inlet temperature – 25^{0}C, Outlet temperature – 80^{0}C. Estimate **A. Solar collector area requirement** **B. Cost of the system** **Consider** Specific heat capacity of water – 4.2 kJ/kg^{0}C Efficiency of the Solar system – 55% Design Value of Irradiance – 700 W/m^2 Cost per m^2 of system – Rs 12000	**10**	**CO3**
	SECTION-D **2Qx15M= 30 Marks**		
	India’s solar journey is a tale of turning challenges into opportunities, of harnessing the sun’s boundless energy to light up lives sustainably. On this World Environment Day, India’s solar saga reminds us that with innovation, policy support, and collective will, we can indeed craft a brighter, greener future—one solar panel at a time. As we commemorate World Environment Day, it’s fitting to reflect on India’s ambitious journey in the solar energy sector. With its commitment to sustainable development		**CO4**

and combating climate change, India has set its sights on becoming a global solar powerhouse. However, the path to this green future is paved with both formidable challenges and promising opportunities. This natural bounty, coupled with plummeting solar panel costs, has propelled India's solar capacity from a mere 2.8 GW in 2014 to an impressive 82.6 GW till April 2024 with the highest annual installation of 15 GW achieved in 2023-24 Furthermore, the Union Budget significant allocation to renewable energy projects underscores the country's commitment to harnessing its solar potential.

India's geographical advantage is undeniable. Blessed with about 300 sunny days annually and an average solar radiation of 4-7 kWh/m^2/day, India's solar potential is among the highest globally. To put this into perspective, if just 1% of India's land area were covered with solar panels at 15% efficiency, it could generate over 1,000 GW of power.

Despite this rapid growth, significant hurdles remain. Land acquisition and grid integration: Solar farms require vast tracts of land. In a densely populated country where agriculture dominates, acquiring suitable land without displacing communities or compromising food security is a delicate balancing act. This is particularly challenging in states with high population density and fertile agricultural land. Additionally, India's ageing power grid struggles to handle the intermittent nature of solar energy. Modernizing and expanding the grid to accommodate increasing solar capacity is a costly and complex task. The variability of solar power necessitates advanced grid management techniques and significant investment in infrastructure.

Manufacturing dependencies and financial constraints: Despite the "Make in India" initiative, most solar equipment is imported, particularly from China. This not only widens the trade deficit but also poses supply chain risks, as seen during the COVID-19 pandemic.

Building a robust domestic manufacturing sector for solar components is crucial for long-term sustainability. Moreover, high upfront costs and perceived risks make financing solar projects challenging. Many distribution companies (DISCOMs), burdened by debt, struggle to pay for solar power, deterring investors. Access to affordable finance remains a significant barrier for large-scale solar deployment.

Water scarcity: Solar panels need regular cleaning to maintain efficiency. In water-stressed regions, this creates a dilemma: green energy versus water conservation. Developing water-efficient cleaning technologies is essential to address this issue.

Yet, for every challenge, there's an opportunity:

Rooftop solar: With over 300 million buildings, India's rooftop solar potential is vast. It sidesteps land issues, empowers consumers as 'prosumers' (producer-consumers), and reduces transmission losses. Expanding rooftop solar installations can significantly contribute to the overall solar capacity.

Solar-wind hybrids: Combining solar and wind power can provide more consistent energy, making better use of grid infrastructure. India's diverse geography is perfect for such hybrid projects, which can enhance grid stability and maximize resource utilization.

Green hydrogen: Using solar power to produce hydrogen—a clean fuel—can revolutionize sectors like steel, cement, and heavy transport. India's abundant solar resources make it a potential green hydrogen hub. This can diversify energy sources and reduce dependence on fossil fuels.

Agrivoltaics: This innovative approach allows solar panels and crops to coexist, providing shade for plants while generating power. It could be a game-changer in reconciling solar expansion with agricultural needs, especially in rural areas where land use is a critical issue.

Energy storage: As battery technology advances and costs fall, large-scale storage can solve solar's intermittency issue. India's growing electric vehicle market also synergizes well with solar charging infrastructure. Enhancing energy storage capabilities can ensure a reliable supply of solar energy even during non-sunny periods.

Policy push and innovation
The government's role is pivotal. Schemes like PM-KUSUM support farmers in installing solar pumps and leasing land for solar projects. The recent Production-Linked Incentive (PLI) scheme aims to boost domestic manufacturing of solar equipment. Furthermore, India's ISA (International Solar Alliance) initiative fosters global cooperation in solar R&D and financing.

Innovation is equally crucial. Indian startups are pioneering solutions like solar tiles, transparent solar glass, and AI-driven panel cleaning drones. The Indian Institute of Technology (IIT) Madras has developed low-cost,

	high-efficiency solar cells using N-type Czochralski silicon wafers. Such homegrown technologies could propel India to the solar industry's forefront. Future prospects By 2030, solar energy could meet 30% of India's electricity demand, creating millions of jobs and saving billions in fossil fuel imports. Beyond numbers, solar power symbolizes India's commitment to its Paris Agreement pledges and its vision of "Vasudhaiva Kutumbakam" (the world is one family) in the fight against global warming. The transition to a solar-powered future promises not only economic benefits but also significant environmental and social impacts. As we stand at this environmental crossroads, India's solar journey offers a compelling narrative. It's a tale of turning challenges into opportunities, of harnessing the sun's boundless energy to light up lives sustainably. On this World Environment Day, India's solar saga reminds us that with innovation, policy support, and collective will, we can indeed craft a brighter, greener future—one solar panel at a time. The continued focus on solar energy aligns with global sustainability goals and positions India as a leader in the renewable energy sector. As the world grapples with the urgent need to combat climate change, India's solar energy sector stands as a beacon of hope and a testament to the power of sustainable innovation.		
Q1	Briefly describe the challenges on ambitious targets of solar power generation of India.	**15**	**CO4**
Q 2	Briefly describe the opportunities lies in the above challenges and what are other uses of increased Solar energy in future.	**15**	**CO4**