Form No. T611

Philadelphia University
Faculty of Engineering

Student Name:
Student Number:

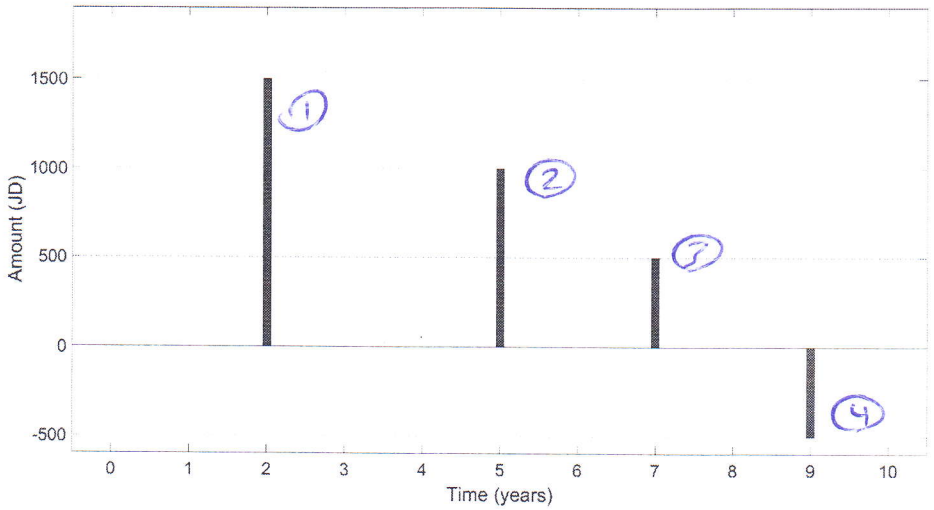
Dept. of Renewable Energy Engineering
Midterm Exam, Second Semester: 2021/2022

Course Title: Energy Economics and Management	**Date: 17/5/2022**
Course No: (611312)	**Time Allowed: 75 Minutes**
Lecturer: Dr. Mohammad Abu-Naser	**No. of Pages: 6**

Question 1: ***(5Mark)***

Objectives: This question is related to Time Value of Money

Based on the following cash flow diagram, calculate the NPV using discount rate of 10%



$$PV_1 = \frac{FV_1}{(1+d)^n} = \frac{1500}{(1+.1)^2} = 1239.7 \text{ JD}$$

$$PV_2 = \frac{1000}{(1.1)^5} = 620.9 \text{ JD}$$

$$PV_3 = \frac{500}{(1.1)^7} = 256.6 \text{ JD}$$

$$PV_4 = \frac{-500}{(1.1)^9} = -212 \text{ JD}$$

$$NPV = PV_1 + PV_2 + PV_3 + PV_4$$

$$= 1239.7 + 620.9 + 256.6 - 212$$

$$= 1905.2 \text{ JD}$$

Question 2: ***(5Mark)***

Objectives: This question is related to Utilization Factor

The following table contains the average irradiance data for Buenos Aires, Argentina in units of kWhr/m^2/day

1) Fill the last row of the table with total sunlight hours for each month?

Month	Jan	Feb	Mar	Apr	May	Jun
Number of days in each month	31	28	31	30	31	30
Solar Irradiance (kWhr/m^2/day)	6.31	5.91	5.34	4.57	3.90	3.39
Total sunlight hours for each month?	31x6.31 =195.6	28x5.91 =165.5	31x5.34 =165.5	30x4.57 =137.1	31x3.9 =120.9	30x3.39 =101.7

Month	Jul	Aug	Sep	Oct	Nov	Dec
Number of days in each month	31	31	30	31	30	31
Solar Irradiance (kWhr/m^2/day)	3.64	4.29	5.23	5.31	5.89	6.12
Total sunlight hours for each month?	31x7.64 =112.8	31x4.29 =133	30x5.23 =156.9	31x5.31 =164.6	30x5.89 =176.7	31x6.12 =189.7

2) What are the total yearly sunlight hours at this location?

Total yearly sunlight hours = $\sum_{1}^{12}$ Total monthly sunlight hours

= 1820 hour

3) What is the average solar utilization factor at this location?

Utilization Factor = $\frac{1820}{365 \times 24}$ = .208

= 20.8%

Question 3: ***(5Mark)***

Objectives: This question is related to Levelized Cost of Electricity

A PV system has a size of 500kW. The system life is 25 years. If the system costs 1 JD/Wp. The utilization factor is 20%. The operation and maintenance cost of the system is 5000 JD/year. Assume 0% discount rate.

1) What is the total cost of the system?

Total Cost = Capital Cost + O&M cost

$= 500\,KW \times \frac{1\,JD}{W} + 5000\,\frac{JD}{year} \times 25\,year$

$= 500{,}000 + 125{,}000$

$= 625{,}000\,JD$

2) What is the total energy produced by the system during the whole life of the project?

Energy = Power × Time × UF

$= 500\,KW \times 25\,year \times 365\,day \times 24\,hr \times 0.2$

$= 21{,}900{,}000\,KWhr$

3) What is the LCOE produced?

$$LCOE = \frac{\text{Total Cost}}{\text{Total Energy Produced}}$$

$$= \frac{625{,}000}{21{,}900{,}000} = .0285\,JD/KWhr$$

Question 4: ***(5Mark)***

Objectives: This question is related to basic concepts of fossil fuels

1) For each type of fossil fuel indicate whether the following operations are easy/hard to do?

Operation:-	Pumping	Transporting	Storing
Gas	hard	hard	hard
Oil	easy	easy	easy
Coal	———	easy	easy

2) Define the meaning of oil Resource and Reserve

Resource: all naturally occuring forms of fossil fuels

Reserve: is only that part of resource that is identified and extractable economically under present market and with the available technology

3) Determine the effect of each of the following factors on resource quantity

Factor	Resource quantity (increase, decrease or no effect)
Increase of oil prices	no effect
New discovery	increase
Extraction	decrease
Extraction technology advancement	no effect

Question 5: ***(5Mark)***

Objectives: This question is related to exploration of fossil fuels

1) Write the four main steps of oil and gas exploration

1) Geographical study
2) Geophysical exploration
3) Seismic survey
4) Drilling

2) If the probability of striking oil is 20% and the NPV of developing the discovered field is 20 million dollars, and the cost of exploration is 1 million dollars, what is the expected monetary value? Is exploration justified in this case?

$EMV = P \times NPV - E$

$= 0.2 \times 20 - 1$

$= 4 - 1 = 3$ million dollars

$EMV > 0 \Rightarrow$ exploration is justified

3) Based on the exploration success curve, fill in the following table

	Beginning of exploration activities	End of exploration activities
Discoveries (Easier or harder)	Easier	Harder
Exploration Cost (Lower or higher)	Lower	Higher

Question 6: ***(5Mark)***

Objectives: This question is related to oil discovery, production, and reserve

A company has a total oil reserve of 20 billion barrels. If the current production rate of oil is 1 billion barrel per year. If the company wants to increase its production rate by 1% next year. Calculate:

1) The reserve to production ratio, R/P ratio?
2) The production to reserve ratio, P/R ratio?
3) The required addition to this year's oil reserve in order to maintain the same R/P ratio for next year?
4) The expected reserve next year if the new additions are achieved?
5) Based on your calculations, confirm "double check" that R/P ratio for next year is the same as that of this year.

1) $\frac{R}{P} = \frac{20}{1} = 20$ years

2) $\frac{P}{R} = \frac{1}{20} = .05 = 5\%$

3) $D_n = (1+rg) P_n$

$= (1 + 20 \times .01) \times 1 = 1.2$ billion barrels

4) $R_{n+1} = R_n + D_n - P_n$

$= 20 + 1.2 - 1 = 20.2$ billion barrels

5) $P_{n+1} = (1+g) P_n = (1+.01) \times 1 = 1.01$ billion barrels/year

$\frac{R_{n+1}}{P_{n+1}} = \frac{20.2}{1.01} = 20$ years