Electrical Engineering Department

EE 622

Term 071

Mid-Term Examination

Date

January 10, 2008

Place

59-2017-108

Time

10:00-11:30

Instructor Name

Dr. Ibrahim El-Amin

Student Id#

Student Name

Q1	
Q2	
Q3	
Q4	
QS	
Total	

Q1 (a) Two oil-fired 400-MW thermal units are on the same bus. The unit cost models are given by:

$$F_1 = 180 + 9P_1 + 0.002P_1^2$$

$$F_2 = 180 + \beta P_2 + \gamma P_2^2$$

- A. For a power demand of 550 MW, the incremental cost of power λ is 10. Find the loading on both units assuming optimal operation.
- B. For a power demand of 700 MW, the incremental cost of power λ is 10.25. Find the loading on both units assuming optimal operation.
- C. Using data in parts A. and B. and, obtain β and γ .
- (b) The incremental fuel cost of a power plant in \$/MWH is given as:

$$\frac{dC_1}{dP_{G1}} = 0.2P_{G1} + 40$$

$$\frac{dC_2}{dP_{G2}} = 0.25P_{G2} + 30$$

Assume that the total load varies from 40 MW- 250 MW and that the generator limits are

$$20 \text{ MW} \le P_{G1} \le 125 \text{ MW}$$

$$20~MW \leq P_{G2} \leq 125~MW$$

How will the load be shared between the units as the system load varies over the full range? What are the corresponding values of the plant incremental costs.

(c) The demand curve for electricity is give by

$$q = \frac{20,000}{\pi}$$

Find the price and demand elasticity for a power demand of 400 MW.

at sptimum dispatch
$$\frac{dF_1}{dP_1} = \frac{dF_2}{dP_3} = \lambda$$

$$9 + 0.004 P_1 = \beta + 28 P_2 = 10$$

$$\lambda = 10-25$$

$$9+0-024 = 10-25; \quad P_{i} = \frac{1.25*10^{3}}{4} = \frac{312-5}{4}$$

$$P_{d} = 700 - 312-5 = \frac{38-7-5}{4}$$

$$\beta + 2\gamma(387-5) = 10-25$$

$$2\gamma(87-5) = 0-25$$

$$\beta = 9.142$$

$$\gamma = 0.00142$$

$$\begin{array}{ll}
E = -\frac{17}{9} \frac{d9}{94 \frac{d7}{d7}} \\
= -\frac{17}{9} \left(\frac{d}{37} \left(\frac{26000}{17} \right) \right) = -\frac{17}{9} \left(\frac{26,000}{17} \right)^{-2} = -\frac{1}{9} \\
Price (17) = 20,000 = 20,000 - 452/4NL
\end{array}$$

any additional lood in them by $g_2 = 1000 \times 10000 \times 100000 \times 10000 \times 100$

7	Pol	Psa	Pg,+ Pg2_	
35	20	20	40	
44	20	53	7-6	
50	50	80	130	
53	75	100	175	
60	100	120	220	
65	125	1251	250	



Consider the market for electrical energy which is made of three generating units whose cost function are as follows:

Unit A
$$15 + 1.4P_A + 0.04P_A^2$$

Unit B $25 + 1.6P_B + 0.05P_B^2$
Unit C $20 + 1.8P_C + 0.02P_C^2$

Assume that the inverse demand curve of the market is given by :

Each generator seeks to maximize its profits.

- Write and solve the optimality condition of the energy market.
- (ii) Write and solve the optimality condition if the inverse demand curve is given by: $\pi = 100 \text{-}D^2 \qquad \text{S/MWh}$

$$R_{A} + P_{B} + P_{C} = D$$

$$T = 300 - (P_{A} + P_{B} + P_{C})$$

$$R_{A} = P_{A} (300 - (P_{A} + P_{B} + P_{C})) - (S + 1.4 P_{A} + 0.04 P_{A}^{2})$$

$$R_{B} = P_{B} (300 - (P_{A} + P_{B} + P_{C})) - (2S + 1.6 P_{B} + 0.05 P_{B}^{2})$$

$$R_{C} = P_{C} (300 - (P_{A} + P_{B} + P_{C})) - (2D + 1.8 P_{C} + 0.02 P_{C}^{2})$$

$$R_{C} = P_{C} (300 - (P_{A} + P_{B} + P_{C})) - (2D + 1.8 P_{C} + 0.02 P_{C}^{2})$$

$$R_{C} = P_{C} (300 - (P_{A} + P_{B} + P_{C})) - (2D + 1.8 P_{C} + 0.02 P_{C}^{2})$$

$$R_{C} = ST76.903$$

$$R_{$$

Q3 An electricity retailer forecast its consumer load requirements for an 8-hours period.

- The retailer buys energy on a Future market to cover exactly the forecasted load. The average price paid each hour is shown below.
- The retailer buys and sells the difference between the actual and forecasted demand in the spot market.
- The retailer sells the energy to consumers following a changing to reflect time
 of use.
- (i) Calculate the profit or loss of the retailer
- (ii) What will be the average rate of sales to consumers for the retailer to breakeven?

Period	1	2	3	4	5	6	7	8
Load Forecast (MWh)	100	150	220	340	340	270	200	160
Actual Load (MWh)	120	160	250	350	370	240	190	150
Average Price (\$/MWh)	22.5	22.5	27.5	30	30	28.5	24	24
Spot Price (\$/MWh)	21.5	21.5	25	35	35	30	28	25
Consumer Tariff (S/MWH	20	20	28	38	38	25	25	25

Column1	100 A 100 A		100000000000000000000000000000000000000	(1)	1000	2000		AND AND								
Column2			1			Mary Control		SEU PAR				5月 与 经				
Column3 Period Load Forecat (MWh) Actual Load (MWh)	Actual Load (MWh)	Average Price (\$/MWh)	3	Contract Farmer	Payment for Energy (\$)	Spot Market transactions(\$)	Revenue from Sales (\$)	Profit (\$)	The state of the s		Average Price (\$/MWh)					
100 120	120 22.5	22.5	20		2250	-430	2400	-280		1	25.71	2.7				
8					3375				7.87			かてしま				
3 220 250					6050	023	7000	200	1			lik.			X	
340 350	350	36	38		10200	-350	13300	2750	1			100	NE O			
5 340 370	370	35	38		10200	-1050	14060	2810							0	
6 270 240	1	75			7695	900	50	-795	70.11	4		-		П		
7 7 7 7 7 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	190 24	28	25		4800	280	4750	230					Y C			
160 150	150 24	25	25		3840	250	3750	160	150				5		F	
1830					48410	N. Cal	cn cn	4685				DOT THE				
Commission				7		ESC. INC.						ALT COMP	1			

A company own an old power plant which is made of 6 units 50 MW each. The hate rate of the unit is 11,597 Btu/kWh. The generating units burns natural gas at a cost of \$4.0/MBtu. The fixed cost operating expenses of each unit is \$500/month while the variable operating expenses of the unit are \$0.2/MWh.

- What will be the minimum sale prices to keep the plant runnig if the utilization factor is only 10%.
- (ii) What is the average cost of generation at the plant?
- (iii) What will profit (loss), if the regulator has imposed a price cap of \$40/MWh.

- Valley and the same of the s		
Column1	Column2	Column3
Control of the second		SHEW LINE
Capacity (MW)	50	
Number of units	6	-
Heat rate (Btu/kWh)	11596	
uilization factor	0.1	arilla -
Fuel price (\$/MBTU)	4	
Fixed cost (\$/month)	500	
Variable Operating Expenses (\$/MWh)	0.2	
Number of hours	8760	ELEMENT.
Energy produced(MWH)	262800	
Annual production cost (\$/year)	12189715	
Total Fixed Expenses	36000	
Variable Operating Expenses	52560	
Total cash flow	12225715	
Price (\$)	46.520986	5
Tariff (\$/MWh	40	
Revenue	10512000	
Profit	-1713715.2	2
CONTRACTOR WATER TO SEE BY	Creb Miles	Siena
WAREING SERVICE	100	
Capacity (MW)		1
Number of units	13000	
Heat rate (Btu/kWh)	0.0	
uilization factor		
Fuel price (\$/MBTU)	2.9	
Fixed cost (\$)	360,000	
Number of hours	876	
Energy produced(MWH)	876	
Annual production cost (\$/year)	33025	
Cash flow	690,25	
Price	78.7958	9

Q5 An electricity generating company own a power plant and is active in trading of electric energy. The following positions are etsablished between 18:00-19:00 hours.

- The power plant produces 2000 MWh at an evrage cost of \$32.5/ MWh
- Long term contact for the purchase of 1000 MW during the peak hours at a price of \$30/MWh.
- 3. Future contract for the purchase of 500 MWh at \$29.5/MWh.
- 4. A call option for 220 MWh at an exercise price of \$28.5/MWh.

The total demand during the period 18:00- 19:00 is 4500 MWh and is sold as follows:

- Long term contact with an industrial consumer for the sale of 750 MW at the rate of \$30/MWH.
- Long term contact with a commercial consumer for the sale of 250 MW at the rate of \$32/MWH.
- 3. A future contact to sell 250 MWh at \$27/MWH.
- A put option for the sale of 500 MWh at an exercise price of \$33/MWh.
- The remaining energy is sold to customers at the rate of \$31.5/MWh

The company covers the imbalances from the spot prices. The spot price is \$31.25/MWh.

Calculate the profit or loss of the company.

Lumiloo	Column2	Columns	column4	eojumns	Profit (a)
Item and the second	Energy bought (MWh) Energy sold (MWh) Price (\$/MWh) Expenses (\$) Reven	Energy sold (MWh)	Price (\$/MWh)	Expenses (\$)	ues (\$
Industrial customer	STATE OF STREET	750	30	0	22500
Commercial Customer		250	32		8000
Commonder Carron		2750		0	2022
Other customers	H H TO THE TO	1 2750	0		02000
Future contract		250	27	0	6750
Put option	The state of the s	500	. 35	0	17500
l ong-term contract	1000		30	30000	0
Future contract	500	The second second	29.5	14750	0
Call option	220		28.5	6270	0
Generation	2000		32.5	65000	0
Balancing spot purchase	780		31.25	24375	0
		STATE OF STA		TO KIND	STATE OF THE STATE
150 MW call option fee				0	0
200 MW put option fee		Say In the say	St. Commercial	0	0
300 MW call option fee				0	0
				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	STATE OF STREET
Balance	4500	4500	四十八十二十二日	140395	141375