1) *Planning considerations*

List and briefly explain 6 things that should be considered in distribution network planning.

2) *Regulation and reliability*

a) What part(s) of the electricity business sector is (are) considered to be suitable for competition?
b) What part(s) of the electricity business sector is (are) a natural monopoly?
c) Why is this type of monopoly 'natural'?
d) Why is regulation required?
e) How does regulation achieve its aims?
f) Give two methods by which a regulation authority can encourage reliability (availability of supply).

3) *Reliability*

Examine the following distribution network.

a) Which customers experience an interruption and for how long when a fault occurs at point ***A***? At point ***B***? At point ***C***?

b) What is the total interruption cost caused by a single fault at point ***C*** if the CIC values for all customers are €1 / kW / fault and €10 / kWh, the manual switching time is 1h, the remote switching time is 0.15 h, the substation circuit breaker operating time is insignificant, the repair time is 10 h and the maximum demand (on which the CIC values are based) at each secondary substation is 1 MW?

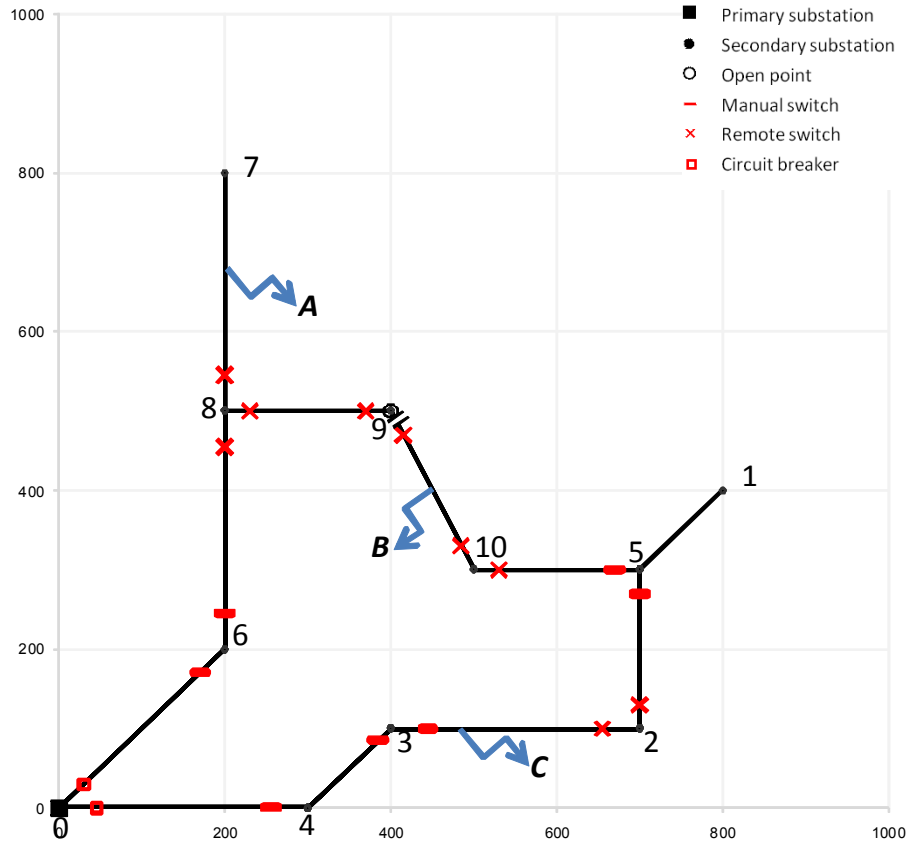

Fig. 1 20 kV network, 1 primary substation (node 0) and 10 secondary substations, each with 1 MW demand

4) ***Markets***

Three companies operating in an electricity market are as follows:

Gen1: A small power producer producing up to 150 MW max
Ret1: An electrical energy retailer, with an obligation to supply
Trad1: A trading company

All parties can buy and sell energy on the spot market and make financial contracts with other parties but each hour of delivery they must settle any imbalance at the system price for that hour. This price is known the day before. We assume that they can settle imbalances in the hour-ahead market at the system price without any penalty (e.g. Elbas in Nordpool).
The hour of physical delivery we are concerned with is March 2, 2011, between 12.00 and 13.00

Long-term bilateral contracts

- Gen1 has a long-term contract covering the hour of delivery for the supply of 80 MW at 35 €/MWh
- Ret1 has a contract covering the hour of delivery to purchase 90 MW at 36 €/MWh

Forwards and futures contracts valid for the hour of delivery (March 2 between 12.00 and 13.00)

Date	Company	Type	Amount (MW)	Price (€)
1/12/10	Trad1	Buy	5	38.00
30/12/10	Trad1	Buy	15	37.50
4/01/11	Gen1	Sell	20	35.50
19/01/11	Ret1	Buy	25	36.50
4/02/11	Trad1	Sell	15	38.00
14/02/11	Ret1	Buy	45	36.00
20/02/11	Gen1	Sell	25	36.25
23/02/11	Gen1	Sell	20	36.25
25/02/11	Ret1	Sell	10	36.25
28/02/11	Trad1	Buy	10	36.50
28/02/11	Gen1	Buy	30	36.75
1/03/11	Trad1	Sell	15	36.50

On the day (March 2, 2011, between 12.00 and 13.00)
The system price turned out to be **36.50 €/MWh** between 12.00 and 13.00 on March 2, 2011.

- Gen1 could only produce 100 MW at 32 €/MWh because of an enforced safety check on one of its generation units.
- Ret1's demand was 160 MW, which it retailed to its customers at an agreed tariff of 38.00 €/MWh.

Remember! In this question, all imbalances are settled at the system price.

The task
Calculate the profit or loss made by each company (Gen1, Ret1, Trad1).

5) ***Conductor choice***

A heavily loaded 20 kV urban cable must be built to supply a load node through which the normal initial load at year 0 is 3.0 MW with a power factor of 0.9_{ind}. The load is projected to increase at an average annual rate of 3 % over the review period of 20 years. In addition, being a main trunk feeder, it is required to cope with double the loading during faults on the adjacent feeder to which it is connected via an open disconnector. Faults on underground cables take a long time to repair, so it can be assumed that the temperature of the cables reaches steady-state conditions when being used for back-up purposes.

The total time from the occurrence of a short circuit fault to the circuit breaker opening is 0.4 s.

The distribution company prefers to use either the AHXAMK-W 3x120 or AHXAMK-W 3x240 XLPE cables in their MV network.

Is one of these cables suitable? Justify your answer.

Cable type	r Ω/km	x Ω/km	Max steady-state load current (A)	$I_{sc,1s}$ (kA)
AHXAMK-W3x120	0.3	0.123	265	11.4
AHXAMK-W3x240	0.15	0.11	375	22.6