

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (20%) A three-phase transmission line serves a load of 400 MVA, 0.8 lagging power factor at 345 kV. The ABCD matrix of the 480km line is shown below.

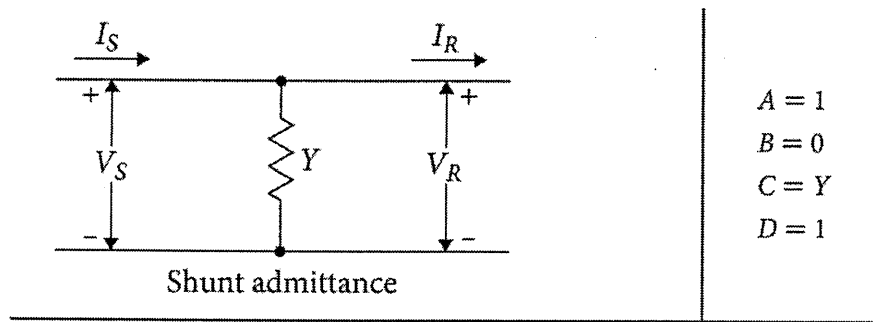
$$A = D = 0.8 \angle 1^\circ$$

$$B = 170 \angle 80^\circ \Omega$$

$$C = 0.002 \angle 90^\circ \text{ S}$$

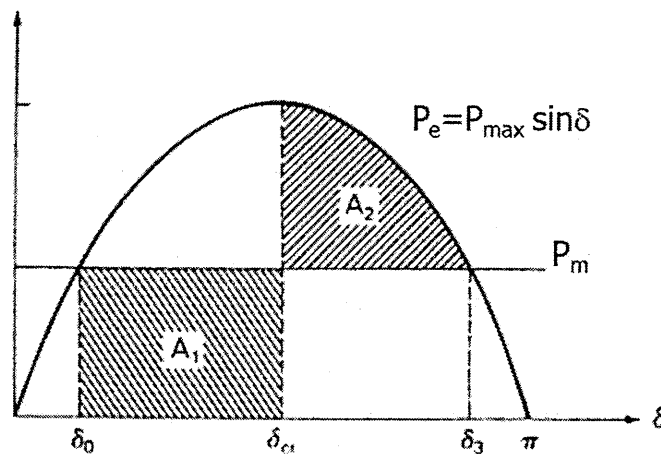
- (a) (10%) A 250-Mvar, 345-kV shunt reactor whose admittance is  $0.002 \angle -90^\circ \text{ S}$  is connected to the receiving end of the 480 km line. Determine the **equivalent ABCD constants** of the line combined with the shunt reactor;
- (b) (10%) Determine the **sending-end line-to-neutral voltage**, the **sending-end current**.

**Hint: the shunt admittance matrix**

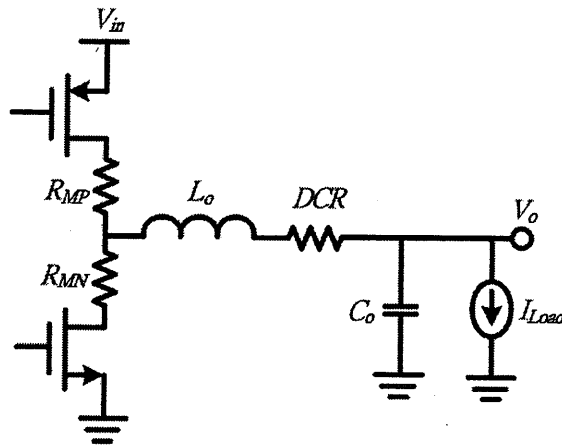


2. (20%) A three phase synchronous generator is operating in power balance with mechanical power of  $P_m$  and electrical power of  $P_e$ . The inertia of the generator is 2H and the nominal frequency is  $f_0$ . A three phase bolted fault occurs at the generator terminal. The power curve is given with the parameters shown below. Please derive the followings:

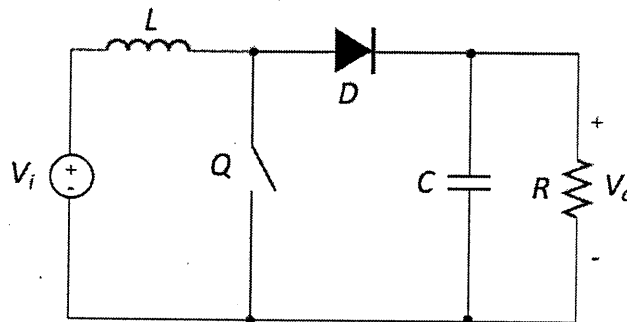
- (a) (10%) **critical clearing angle  $\delta_{cr}$**  in terms of the parameters ( $\delta_0, \delta_3, P_m$  and  $P_{max}$ );
- (b) (10%) **critical clearing time  $t_{cr}$**  in terms of the parameters ( $\delta_{cr}, \delta_0, f_0, H, P_m$ ).



3. (10%) The equivalent Buck converter circuit is shown in the figure below. The parasitic resistance of the MOSFET switches P-MOS, N-MOS are  $R_{MP}$  and  $R_{MN}$ , respectively. The equivalent DC resistance of the inductor  $L_o$  is  $DCR$ . Assume that the Buck converter is operating at steady-state and neglect the effect of capacitor current. Please **prove** that the duty ratio  $D$  is affected by the input voltage  $V_{in}$ , output voltage  $V_o$ , and load current  $I_{Load}$ .



4. (11%) An ideal boost converter is show in the following figure.



- (a) (7%) Assuming  $Q$  and  $D$  are also ideal, “derive” the voltage gain  $V_o/V_i$  as function of duty cycle of switch  $Q$ .
- (b) (4%) If  $V_i = 20$  V,  $L = 100$   $\mu$ H,  $C$  is very large, duty cycle of  $Q$  is 50% and switching frequency is 50 kHz. What  $R$  should be to make the mode of operation discontinuous?
5. (14%) A three-phase Y-connected 60 Hz synchronous generator operates at the rated condition with 20 kV and 100 MVA. The per-phase armature resistance and synchronous reactance are respectively 0.16  $\Omega$  and 1.6  $\Omega$ .
- (a) (7%) What is the voltage regulation for the generator operating at the rated condition with 0.9 lagging power factor?
- (b) (7%) What is the voltage regulation if the power factor is 0.9 leading?

6. (12%) Under some load condition, a three-phase induction motor rated 60 Hz, 220 V, 25 hp is drawing a line current of 50 A from the power source at 0.85 lagging power factor. In this condition, the stator copper loss is 600 W, iron loss is 300 W, rotor copper loss is 500 W and rotational loss is 400 W. Calculate:
- (a) (3%) air-gap power;
  - (b) (3%) slip in %;
  - (c) (3%) mechanical output power;
  - (d) (3%) efficiency.
7. (13%) For a shunt DC generator (self-excited generator),
- (a) (5%) draw and explain the equivalent circuit;
  - (b) (4%) assuming that there is residual magnetic flux for the generator to start up, describe the start-up process till steady-state operating speed;
  - (c) (4%) would the field resistance affect the start up? If yes, how?