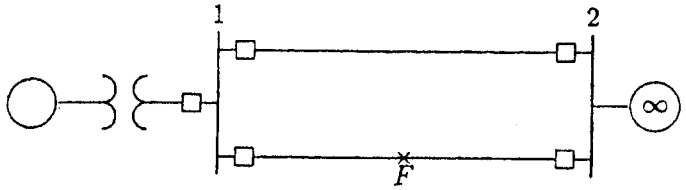
1. (20%) One 60 Hz machine system connected to infinite bus is shown below. Assume the input mechanical power P_m is constant, the generator is delivering power steadily with a power angle δ_o. Consider a temporary three-phase bolted fault occurs at point *F* where *F* is at some distance away from the sending end. The fault is then cleared at power angle δ_C by removing the faulty line. Due to the energy conversion, the power angle reaches δ_{max} at the stable operating region. The power angle finally returns to a new stable operating point at δ_1.



Please answer the following:

I. (15%) Draw the power angle curves (electric power P_e vs. power angle δ), and power line P_m. Label the operating points associated with δ_o, δ_C, δ_{max}, δ_1 on the curves.

II. (5%) Mark and discuss the areas for the stability criteria.

2. (20%) With the same 60Hz power system structure in the previous question, assume the generator has inertia constant H=5MJ/MVA, a direct transient reactance X_d'=0.3 pu is connected to a transformer with reactance X_t = 0.1pu. Between the transformer and infinite bus, a pair of transmission lines (each line's reactance is 0.6pu) are delivering real power P_e = 0.8pu and Q = 0.08pu to the infinite bus at a voltage of V = 1pu.

I. (10%) Consider the first-order differential equation

$$\frac{dx}{dt} = f(x)$$

Express the solution x(t) by using Euler's method and point out its flaw

II. (10%) A sudden line trip occurs on one of the transmission line and the faulty line is removed immediately at t = 0 second. Please find the power angle δ in degree and rotor speed deviation $\Delta\omega$ in rad/sec after the fault at t = 0.02 second. Using the Euler method with a step size of Δt = 0.01 second. Perform two iterations.

swing equation: $$\frac{d^2\delta}{dt^2} = \frac{\pi f_o}{H}(P_m - P_{max}\sin\delta)$$

(背面仍有題目,請繼續作答)

3. (20%) The following data were obtained for a 20kVA, 60Hz, 2kV: 200V distribution transformer tested at 60Hz:

With high –voltage winding open-circuited	240V	1A	120Watts
With low-voltage terminals short-circuited	50V	8A	280Watts

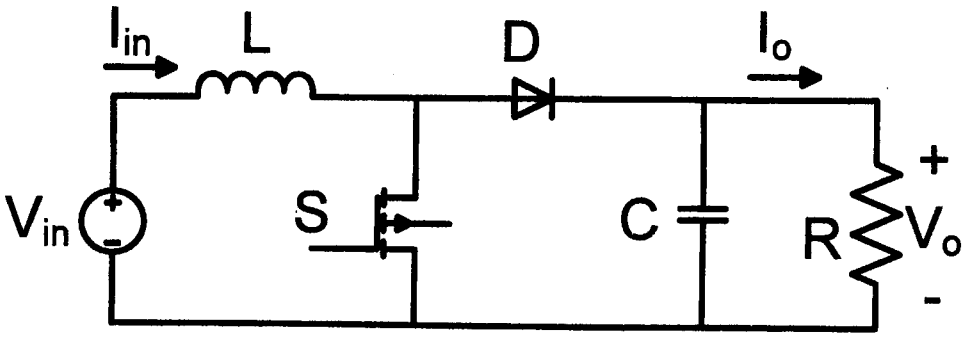
a) (10%) Compute the efficiency at full-load current and the rated terminal voltage at 0.8 lagging power factor.

b) (10%) Assume that the load power factor is varied while the load current and secondary terminal voltage are held constant. Use a phasor diagram to determine the load power factor for which the regulation is greatest. What is this regulation?

4. (20%) As following figure, Vin=10V, L=1mH, R=500Ω, the switching frequency is 100kHz and duty cycle of S is 50%.

a) (10%) Is this converter operating in continuous mode or discontinuous mode? And why?

b) (10%) What is the output voltage Vo and the average input current Iin?



5. (20%) Short Answer

a) (7%) What are the differences between ZCS (zero current switching) and ZVS (zero voltage switching)?

b) (7%) What are the advantages of the double-squirrel-cage rotors?

c) (6%) How to obtain the reverse rotation of the single-phase induction motors?