Homework #3 (2024 Spring, EE 171)

- Deadline: June 10th 8:00 a.m.
- Please submit your homework through Gradescope (Course Entry Code: 3PV4VP)
- Handwriting is not suggested, and a poor format will lose at most 10% of your final score.
- Giving your solution in English, solution in Chinese is not allowed.
- Plagiarism is not allowed. Those plagiarized solutions will get 0 point.
- **Total: 180 points**

Q1. Passive rectifier circuit. In the passive rectifier circuit of Fig. 1, L is very large, such that the inductor current $i(t)$ is essentially dc. All components are ideal. **(80 points)**

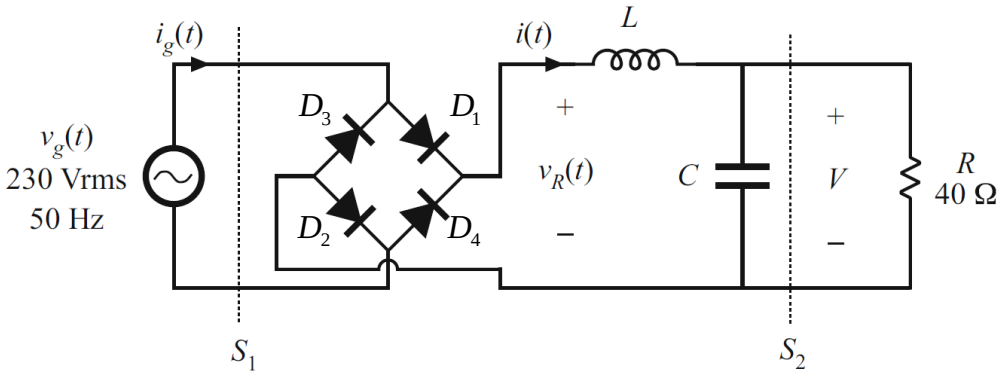

Fig. 1 Passive rectifier circuit

(a) Determine the power factor, measured at surfaces S 1 and S 2. **(20 points)**
(b) Replace D_1 *and* D_3 *with* thyristor Q_1 and Q_3, the thyristor delay angle is α. Analyze the operation mode. Sketch the waveforms $v_R(t)$ and $i_g(t)$; Label the conduction intervals of each thyristor and diode. **(40 points)**
(c) Derive an expression for the output voltage V, as a function of the rms line-line voltage and the delay angle. Derive an expression for the power factor. **(20 points)**

Q2. The voltage v across a load and the current i into the positive-polarity terminal are as follows (where ω_1 and ω_3 are not equal):

$$v(t) = V_d + \sqrt{2}V_1\cos(\omega_1 t) + \sqrt{2}V_1\sin(\omega_1 t) + \sqrt{2}V_3\cos(\omega_3 t) \quad \mathbf{V}$$
$$i(t) = I_d + \sqrt{2}I_1\cos(\omega_1 t) + \sqrt{2}I_3\cos(\omega_3 t - \phi_3) \quad \mathbf{A}$$

Calculate the following:

(a) The average power P supplied to the load. **(10 points)**
(b) The rms value of v(t) and i(t). **(20 points)**
(c) The power factor at which the load is operating. **(10 points)**

Q3. In the circuit Fig. 2, v_{s1} and v_{s2} have an rms value of 120V at 60Hz, and the two are 180° out of phase. Assume L_s=5mH and I_d=10A is a dc current. For the following two values of the delay angle α, (i) 45° and (ii) 135°.

(a) Obtain v_{s1}, i_{s1} and v_d waveforms. **(30 points)**

(b) Calculate the average value V_d and the commutation interval u **(30 points)**

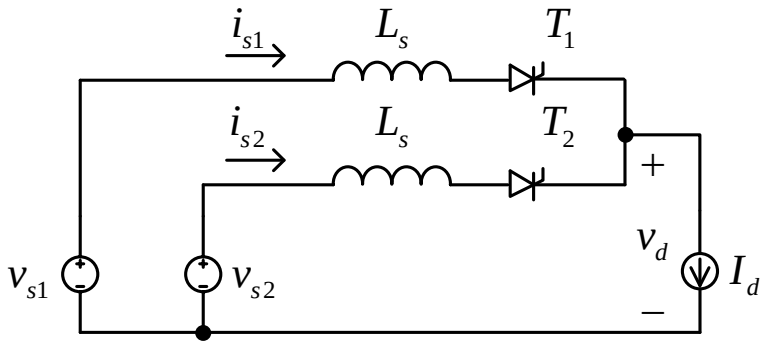

Fig. 2