

Electrical Machinery Laboratory: Final Test (2022.06.15, 15:30-18:00)

**A. Power Electronics**

1. The commonly used power devices include **diode, SCR, MCT, BJT, MOSFET, IGBT, TRIAC**, etc.

- (1) Which device is uncontrolled turn-on and turn-off: \_\_\_\_\_. (2%)
- (2) Give the devices that requires continuous gate signal: \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_. (6%)
- (3) Give the devices that requires pulse gate signals: \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_. (6%)

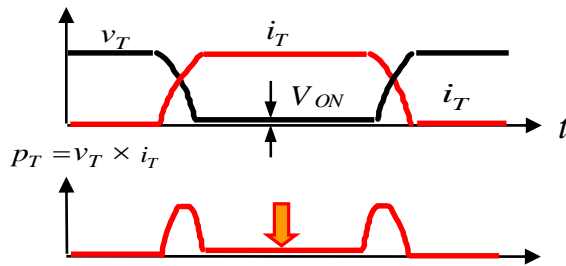
2. The wide-bandgap devices can be turn-on and turn-off faster than Si-based devices. There are two kinds of wide-bandgap devices: \_\_\_\_\_ and \_\_\_\_\_. (4%)

3. Which device has **negative** temperature coefficient and is **not** suitable for parallel operation?

MOSFET or BJT: \_\_\_\_\_. (2%)

4. A IGBT is the combination of \_\_\_\_\_ and \_\_\_\_\_. (4%)

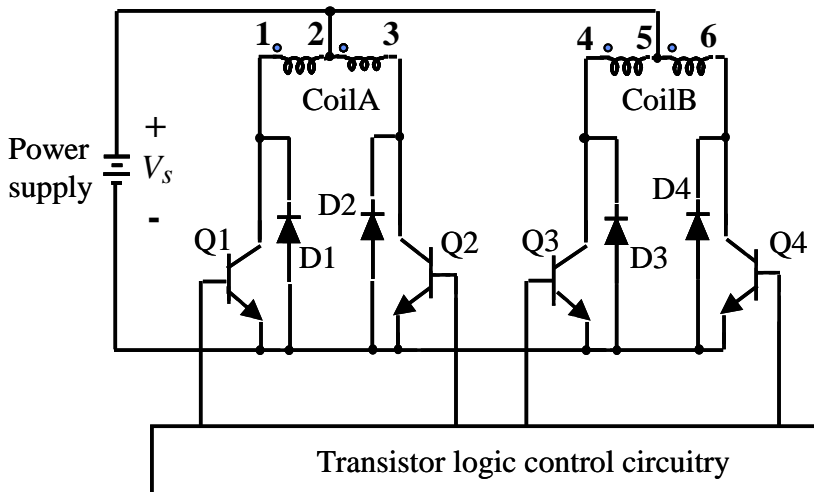
5. Indicate the conduction loss and switching losses for a power semiconductor switch: (6%)



**B. Stepping Motors**

1. For the stepping motor drive circuit as shown:

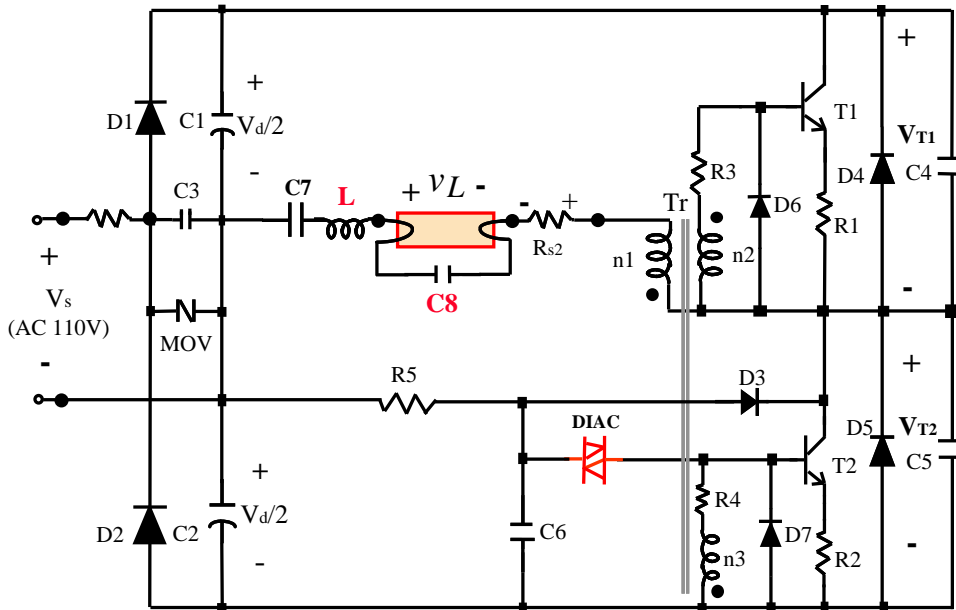
- (1) The winding is bifilar or unifilar? \_\_\_\_\_. (2%)
- (2) The drive is bipolar or unipolar? \_\_\_\_\_. (2%)
- (3) Draw or describe the current paths as: (a) Q1 is ON; and (b) Q1 is off. (6%)
- (4) Indicate the possible places for the speed up resistor. (6%)



## C. Electronic Fluorescent Lamp

1. For the half-bridge electronic fluorescent lamp circuit as shown:

(1) Briefly describe its operation principle. (10%)



(2) Refer to given schematic, give the purposes of the following circuit components: (9%)

MOV: \_\_\_\_\_.

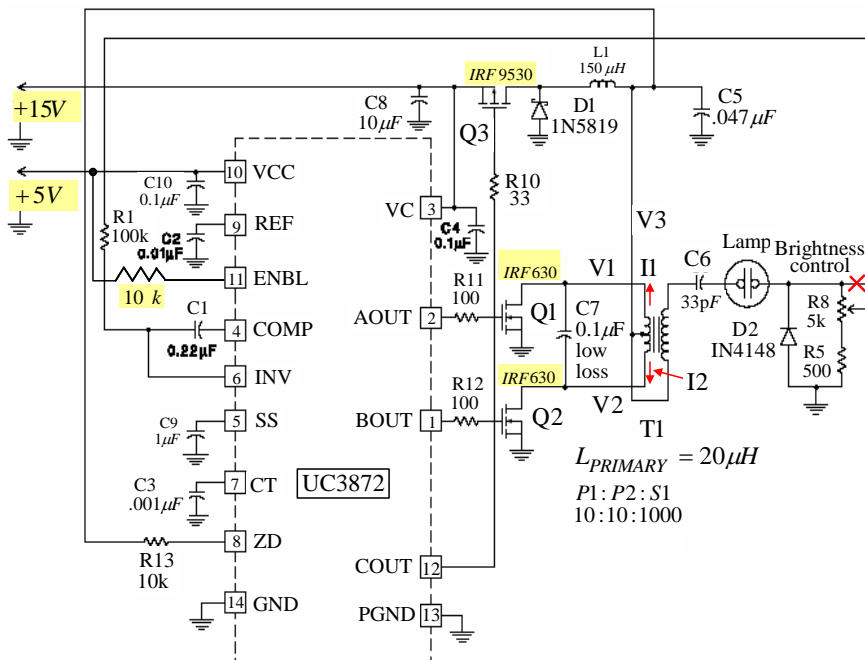
D4, C4, D5, C5: \_\_\_\_\_.

DIAC: \_\_\_\_\_.

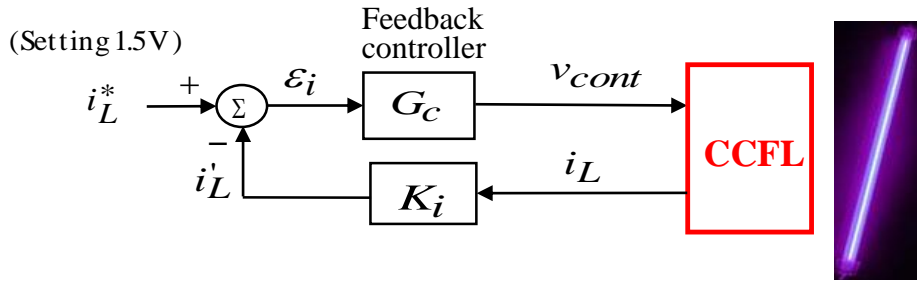
## D. Cold Cathode Fluorescent Lamp (CCFL)

1. Briefly describe operation principle of this experiment circuit (given below). (8%)

2. IRF 9530 is P-channel or N-channel power MOSFET? \_\_\_\_\_ . (2%)



3. For the brightness control scheme as given,  $K_i = 2\text{k}\Omega$  is set, find the set current  $i_L = \underline{\hspace{2cm}}$  A. (6%)



4. The devices (Q3, D1, L1) form what type of DC-DC converter? (4%)

### E. Power Transformers and Power Quality

1. Some test data of the given transformer are measured as follows:

OCT:  $V_{oc} = \underline{\hspace{2cm}}$  (V),  $I_{oc} = 2.5$  (A),  $P_{oc} = 150$  (W)

SCT:  $V_{sc} = 150$  (V),  $I_{sc} = \underline{\hspace{2cm}}$  (A),  $P_{sc} = 250$  (W)

(1) For a correct measurement procedure being made, fill in the values of  $V_{oc}$  and  $I_{sc}$ . (6%)

(2) Find efficiencies at (full load, PF= 0.8 lagging) and at (50% rated load PF = 0.8 lagging): (8%)

$$\eta_{1.0} =$$

$$\eta_{0.5} =$$

2. At the a given load, its measured no-load and full-load terminal voltages respectively are: 120V/60Hz and 108V/60Hz. Find the voltage regulation: (4%)

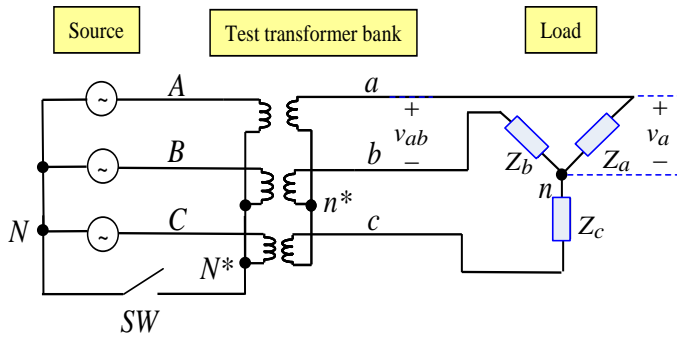
$$\text{VR} = \underline{\hspace{2cm}}.$$

3. The rating of a Delta-Delta connected three-phase transformers is 10kVA. Now a single-phase transformer is removed to form the V-V connection, find its VA rating. (6%)

4. (1) Explain the inrush current generation process of a transformer. (6%)

(2) In what case the inrush current will be minimum? (4%)

5. For the Y-Y connected transformer system as shown:



(1) In which case  $v_a(t)$  possesses 3rd-order harmonics:  $SW$  is closed or opened? \_\_\_\_\_ . (2%)

(2) If  $SW$  is closed,  $Z_a=Z_b=Z_c$  and  $i_A(t) = 5\sin 377t + 1.5\sin(3 \times 377t)$  , find: (4%)

$i_{N^*-N} =$  \_\_\_\_\_ .

(3) Explain what is roving ground? (6%)

6. For the 18-pulse rectifier system applied by multi-phase transformers:

(1) What phase shifts of the output voltage are provided by this system? \_\_\_\_\_ . (4%)


(2) If the frequency of input AC voltage is 60Hz. What is the frequency of the DC-link voltage ripple? \_\_\_\_\_ Hz. (3%)

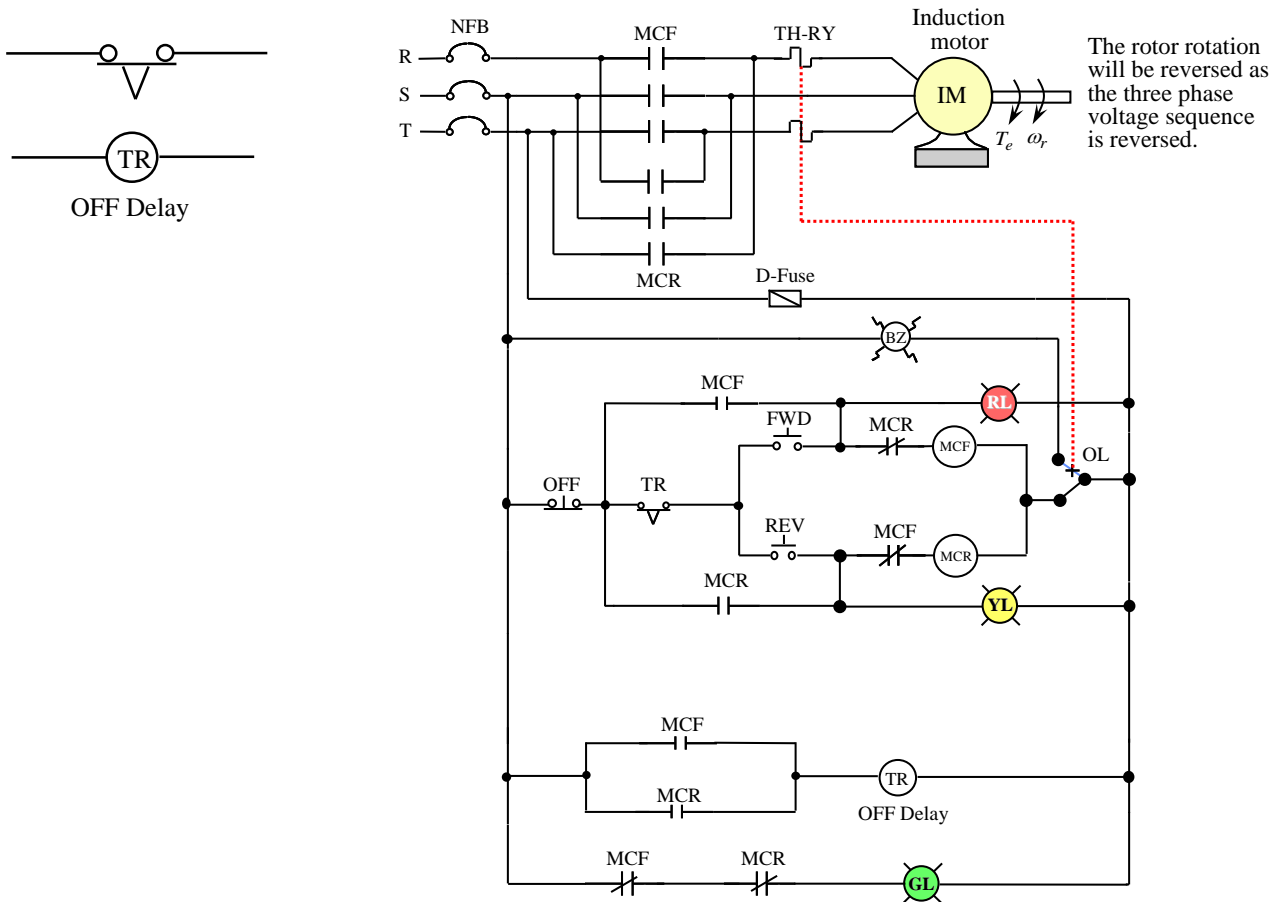
7. For an incandescent lamp (白熾燈) load:

(1) Its power factor PF = \_\_\_\_\_ ; (2%)

(2) Describe why it possesses inrush current? (4%)

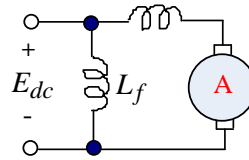
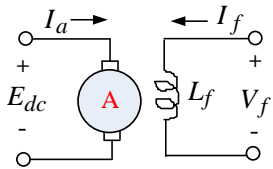
## F. Industrial Control Distribution:

1. How to change the rotational direction of a three-phase induction motor. (3%)
2. For the circuit as shown, as the push button REV is pushed down, describe all the events (including the operations of contacts, lamps, motor, ...) to occur. (15%)
3. What is the component TH-RY? \_\_\_\_\_ . (5%)
4.  belongs to a-contact or b-contact? \_\_\_\_\_ . (3%)
5. Describe the operation of the off-delay relay TR. (6%)

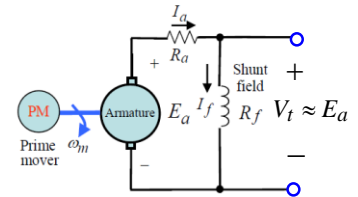
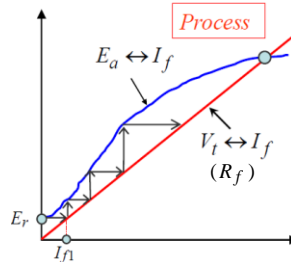


# DC Machines:

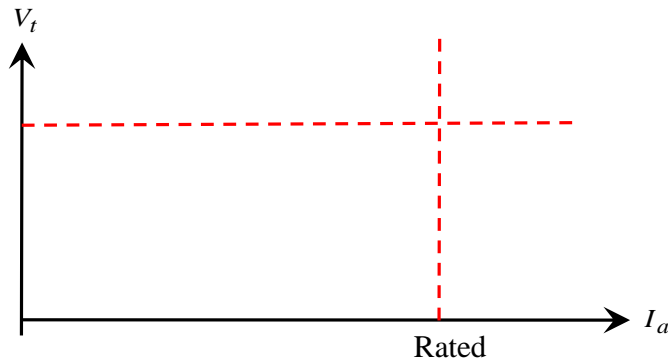
1. Give the name of the following DC machines: (4%)



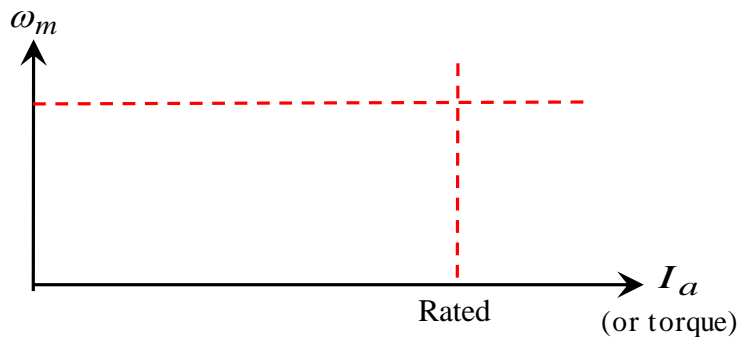
2. (1) Describe the voltage buildup process of a DC shunt generator. (5%)



3. (1) Sketch the terminal voltage vs. load (armature current) curves of the following DC generators in the same figure: Shunt, series, over cumulative compound, differential compound. (8%)

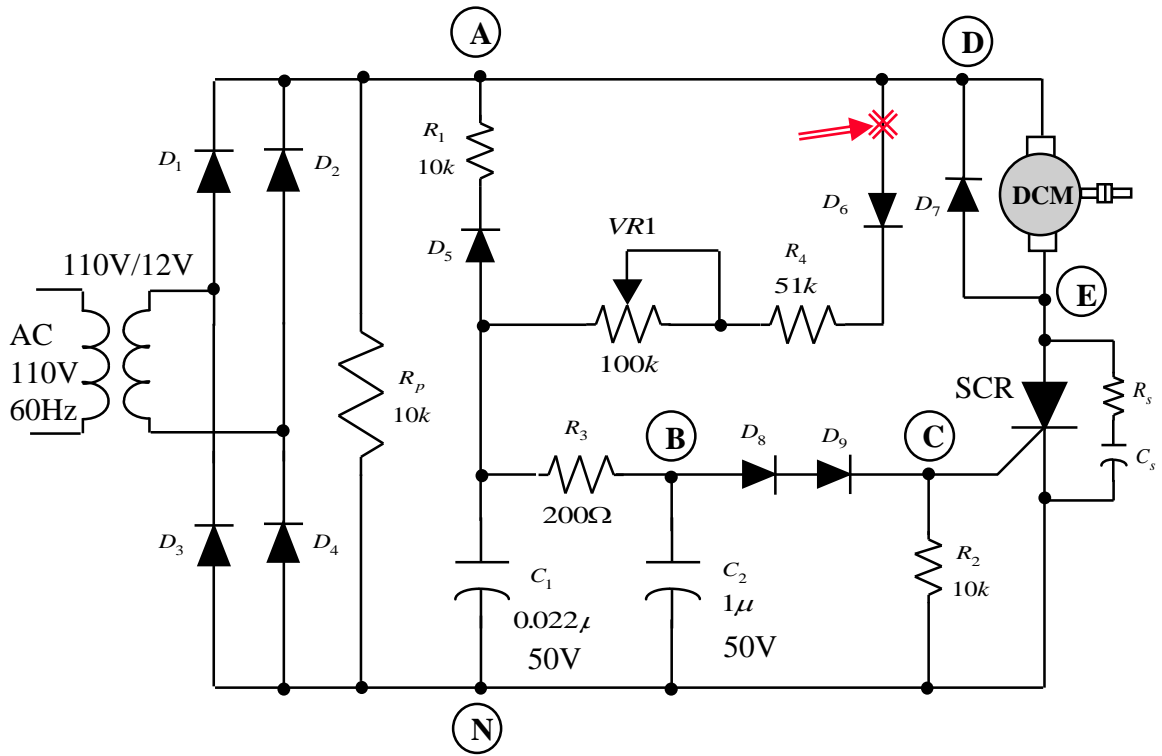


(2) Sketch the speed vs. load (armature current) curves of the following DC motors in the same figure: Shunt, series, cumulative compound, differential compound. (8%)



# SCR Phase Speed Control of DC Motors:

1. Why we can not add a filtering capacitor between nodes (A) and (N)? (4%)



3. Describe the purpose of  $D_7$ . (3%)

4. Describe the purpose of  $VR_1$ . (3%)

5. Describe the difference for the anode  $D_6$  being connected to point (D) and (E). (5%)