國 立 臺 北 科 技 大 學

105 學年第一學期電機系博士班資格考試

交流電機控制試題

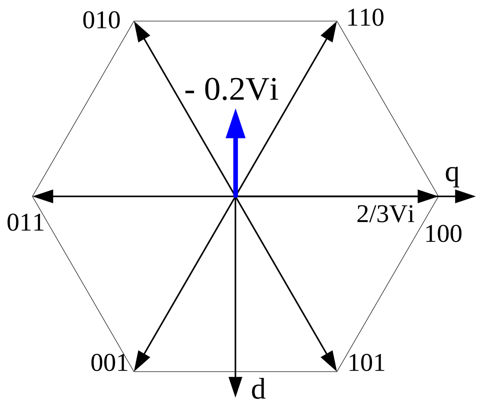
注意事項：

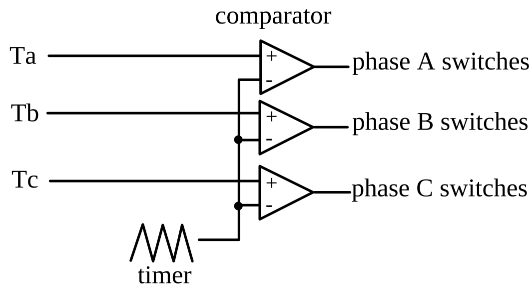
1. 本試題共【4】題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在試卷答案欄內，否則不予計分。
4. 考試時間:二小時。
5. 可以使用計算器。

(1) *(25%)* “Vector control” is commonly used in high performance AC motor drives today. Although both induction motor and permanent magnet synchronous motor (PMSM) are AC motor, implementation of vector control in these motor drives are considerably different. Explain the differences?

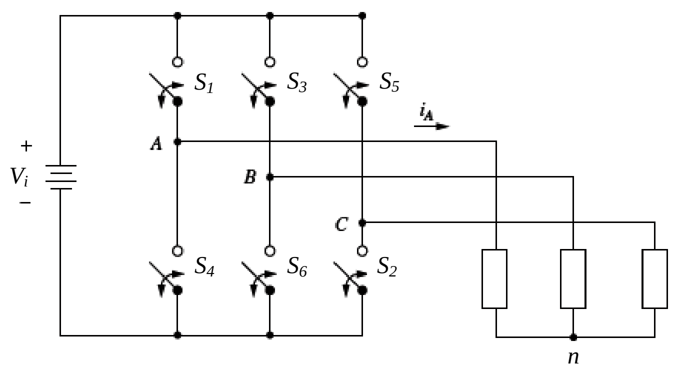
(2) (*25%*) The phase inductance of interior-permanent-magnet type permanent magnet synchronous motor (IPM-PMSM) is non-uniform with respect to rotor angle. Explain how to measure d-axis and q axis inductances (Ld and Lq) of IPM-PMSM motor? You may use any equipment commonly seen in electric machine or power electronics laboratory.

(3) (*25%*) The power supply of a DC-AC PWM inverter is V_i. The triangle PWM timer counts up and down between 0 and 6000. If sinusoidal-PWM (SPWM) is used and it is desired to output a stationary frame voltage: $v_{qs}^{s} = 0, v_{ds}^{s} = -0.2Vi$, calculate the timer values Ta, Tb, and Tc that will produce this voltage? (Note: As shown in the following figure, Ta, Tb, and Tc are the calculated PWM timer value for phase A, B, and C comparator, respectively)





(4) (*25%*) Following figure shows a three-phase DC-AC Inverter, input power source is V_i and *n* is the neutral point. If switches S4, S6, and S5 are closed (turn on), what is the motor phase voltage V_{An}, V_{Bn}, V_{Cn} = ?



Reference: (參考方程式)

(a) Three-phase and stationary dq frame conversions:

$$f_{as} = f_{qs}$$
$$f_{bs} = -\frac{1}{2} f_{qs} - \frac{\sqrt{3}}{2} f_{ds} \,,$$
$$f_{cs} = -f_{as} - f_{bs}$$

$$f_{qs} = f_{as}$$
$$f_{ds} = -\frac{1}{\sqrt{3}} f_{as} - \frac{2}{\sqrt{3}} f_{bs}$$

(b) Stationary dq frame and rotor dq frame conversions:

$$\begin{bmatrix} f_{qs}^r \\ f_{ds}^r \end{bmatrix} = \begin{bmatrix} \cos\theta_r & -\sin\theta_r \\ \sin\theta_r & \cos\theta_r \end{bmatrix} \begin{bmatrix} f_{qs}^s \\ f_{ds}^s \end{bmatrix}, \quad \begin{bmatrix} f_{qs}^s \\ f_{ds}^s \end{bmatrix} = \begin{bmatrix} \cos\theta_r & \sin\theta_r \\ -\sin\theta_r & \cos\theta_r \end{bmatrix} \begin{bmatrix} f_{qs}^r \\ f_{ds}^r \end{bmatrix}$$

(c) Voltage equations for IPM-PMSM:

Rotor frame: $$\begin{cases} v_{qs}^r = \left(r_s + L_{qs} p\right) i_{qs}^r + \omega_r L_{ds} \cdot i_{ds}^r + \omega_r \lambda_m \\ v_{ds}^r = \left(r_s + L_{ds} p\right) i_{ds}^r - \omega_r L_{qs} \cdot i_{qs}^r \end{cases}$$

$$T_e = \frac{3}{2} \frac{P}{2} \left[\lambda_m i_{qs}^r + \left(L_{ds} - L_{qs}\right) i_{qs}^r i_{ds}^r \right]$$