國立臺北科技大學

九十六學年第二學期電機系博士班資格考試

電力電子應用技術試題

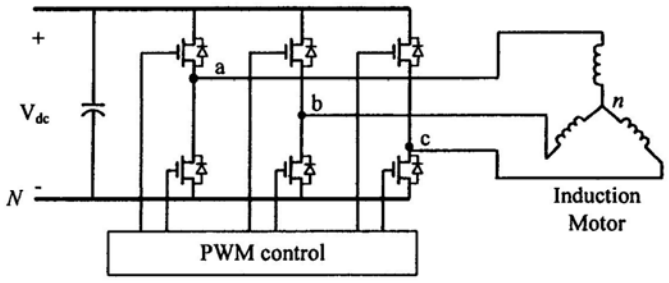
填學生證號碼　　第一頁　共二頁

注意事項：

1. 本試題共[redacted]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。

1. (15%) Give short explanations on the following terminologies: (a) Space voltage vectors, (b) Sine-comparison PWM (SPWM), (c) Space-vector PWM ?

2. (25%) Following circuit shows a three-phase DC-AC Inverter for induction motors. If the motor is modulated with SPWM, frequency modulation ratio $m_f >> 1$, amplitude modulation ratio $m_a < 1$, motor phase voltages are balanced and frequency is ω_e. Consider only the fundamental components, what is the voltage V_{nN} ? Give your proof.



3. (25%) If the bus voltage of an DC-AC inverter is V_{dc}, what is the maximum phase voltage attainable with SPWM without over-modulation? Give your reasoning.

4. (35%) Consider a three-phase, four-poles, induction motor, its parameters are:

Stator resistance (r_s)	=	1 ohm
Rotor resistance (r_r)	=	2 ohm
Stator self inductance (L_s)	=	170 mH
Rotor self inductance (L_r)	=	170 mH
Mutual inductance (L_m)	=	150 mH

The motor's dq equations in the synchronous rotating frame can be expressed as the following matrix:

$$\begin{bmatrix} V_{qs}^e \\ V_{ds}^e \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} r_s + \sigma L_s p & \omega_e \sigma L_s & \frac{L_m}{L_r} p & \frac{L_m}{L_r}\omega_e \\ -\omega_e \sigma L_s & r_s + \sigma L_s p & -\frac{L_m}{L_r}\omega_e & \frac{L_m}{L_r} p \\ -\frac{L_m}{\tau_r} & 0 & \frac{1}{\tau_r} + p & \omega_e - \omega_r \\ 0 & -\frac{L_m}{\tau_r} & -(\omega_e - \omega_r) & \frac{1}{\tau_r} + p \end{bmatrix} \begin{bmatrix} i_{qs}^e \\ i_{ds}^e \\ \lambda_{qr}^e \\ \lambda_{dr}^e \end{bmatrix}$$

where p=d/dt, $\tau_r = \frac{L_r}{r_r}$, and $\sigma = 1 - \frac{L_m^2}{L_s L_r}$. The torque equation is

$$T_e = \frac{3}{2}\frac{P}{2}\frac{L_m}{L_r}\left(\lambda_{dr}^e i_{qs}^e - \lambda_{qr}^e i_{ds}^e\right)$$

The motor is operating under **rotor flux field orientation**, steady state, and its currents are controlled perfectly. If the rotor flux λ_{dr}^e = 0.5Wb, ω_r = 900 rpm, and output torque = 3 Nm. Answer the following questions:

a) What is the d-axis current i_{ds}^e =?

b) What is the q-axis current i_{qs}^e =?

c) What is the rotor's electrical speed ω_e = ? (in rad/sec)

d) Neglect the stator resistance, calculate at what speed (rpm) the motor line voltage is 200 VAC(rms)?