Menoufiya University
Faculty of Engineering
Department of Electrical Engineering

Course: Power Electronics (1)- (ELE 616) *Date : 31 / 12 / 2016*
Time : 3-Hour *Marks : 100*

Post Graduate Exam (M.sc)

Answer the following questions:

Question (1) *(25-Mark)*

1.1) A 230 V, 960 rpm, 20 A, separately excited dc motor has armature circuit resistance and inductance of 1.2Ω and 50 m H respectively. The motor is controlled by a single-phase half-controlled rectifier with source voltage of 230 V, 50 Hz. Calculate no load speeds, and speeds and developed torques on the boundary between continuous and discontinuous conductions for $\alpha = 45^0, and 135^0$.

1.2) A single- phase semi-converter is operated with an uniform PWM control and is supplied from 220 V, 50 Hz supply. The load current with an average value of I_a is continuous with negligible ripple content. There are four pulses per half cycle, each pulse has a width $\delta = 25^0$ and the pulses are started at $\alpha_1 = 10^0, \alpha_2 = 55^0$, $\alpha_3 = 100^0$, *and* $\alpha_4 = 145^0$. The modulation index M=0.8. Calculate:

(a)The average output voltage, V_{dc};
(b)The harmonic factor of input current, HF:
(c)The distortion factor, DF;
(d)The input power factor, PF.

Question (2) *(25-Mark)*

2.1) A single-phase full-wave controller supplies an RL load. The input rms voltage is V=220 V, 50 Hz. The load is such that L=0.008 H and R=2.513Ω. The delay angles of thyristors are equal: $\alpha_1 = \alpha_2 = \frac{\pi}{3}$. Determine:

(a) The conduction angle of thyristor, δ;
(b) The rms output voltage, V_o;
(c) The rms thyristor current, I_R;
(d) The rms output current, I_o;
(e) The average current of a thyristor, I_A;
(f) The input power factor PF.
(You can use the curves of figures 1,2, and 3)

2.2) a single-phase/ single-phase cycloconverter is supplying from 220V, 50 Hz source. The load resistance is 2.5 Ω and load inductance is L=20 mH. The frequency of output voltage is 20 Hz. If the delay angles are generated by comparing a cosine signal at source frequency with a sinusoidal reference signal at output frequency. Determine:

P.T.O.

(a) The rms output voltage;
(b) The rms current of each thyristor;
(c) The input power factor PF.

Question (3) *(25-Mark)*

3.1) Explain with aid of sketches the operation of the Buck-Boost regulator of Fig. (4), assuming continuous load current $I_a=I_A$.

3.2) The input voltage of Buck-Boost converter in Fig.(4), V_s=12 V. The duty cycle K=0.25 and the switching frequency is 25 kHz. The inductance, L =150 μH and filter capacitance is C_2 =220 μF. The energy transfer capacitance C_1 =200 μF and inductance L_1 =200 μH. The average load current is I_a 1.125 A.

Determine the :

(a) Average output voltage, V_a;
(b) Peak-to-peak output voltage ripple ΔV_c;
(c) Peak-to-peak ripple current of inductor ΔI; and
(d) Peak current of the transistor, I_p.

Question (4) *(25-Mark)*

A 460 V, 50 Hz, 980 rpm, 6 pole, Y-connected squirrel-cage induction motor has the following equivalent circuit parameters per phase referred to the stator: R_s=0.29 Ω, X_s=0.21 Ω, X_m=13.3 Ω, R_r'=0.145 Ω, X_r'=0.5 Ω.

The motor is supplied from a current source inverter. The flux is maintained at the rated value. Calculate:

1. **The stator current and dc link current when the machine operates at rated torque and 50Hz.**
2. **The inverter frequency and dc link current for a speed of 600 rpm and rated torque.**
3. **The motor speed, stator current, and dc link current for half of the rated torque and inverter frequency of 30 Hz.**

Good Luck

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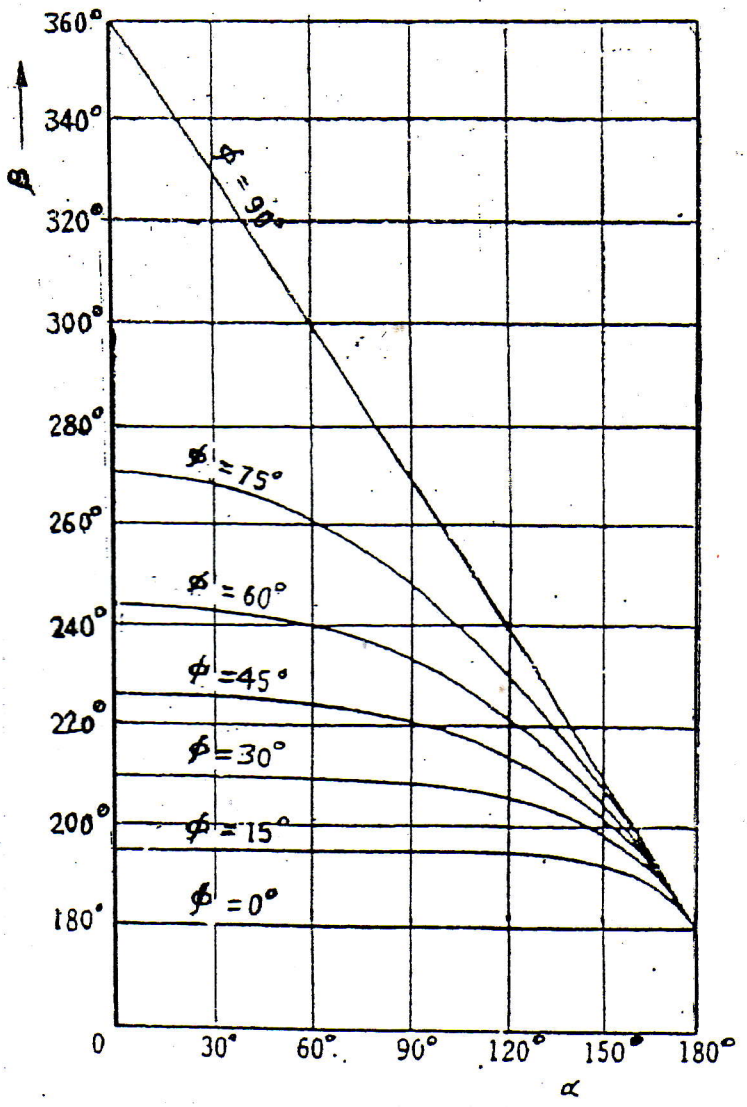

Figure (1) Relation between firing angle(α) and extinction angle (β) for various angle ϕ (load angle).

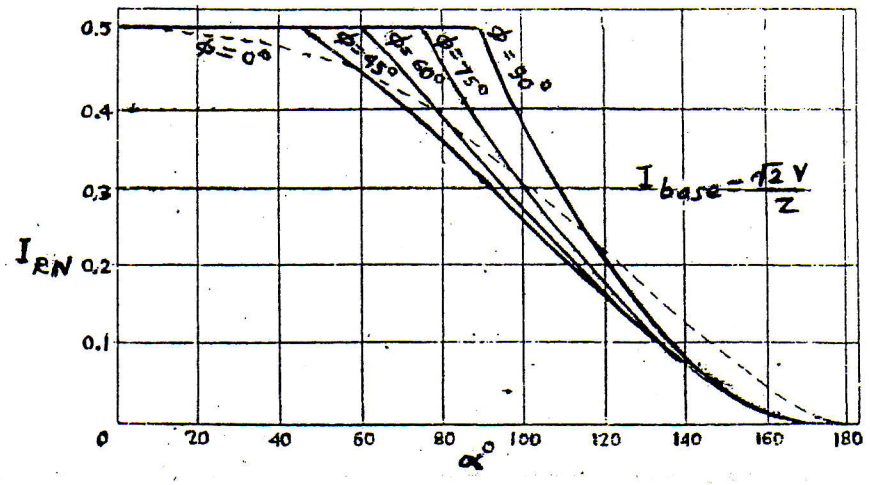

Figure (2) Normalized rms value of the thyristor current (I_{RN}) versus firing angle (α) for various load angle (ϕ).

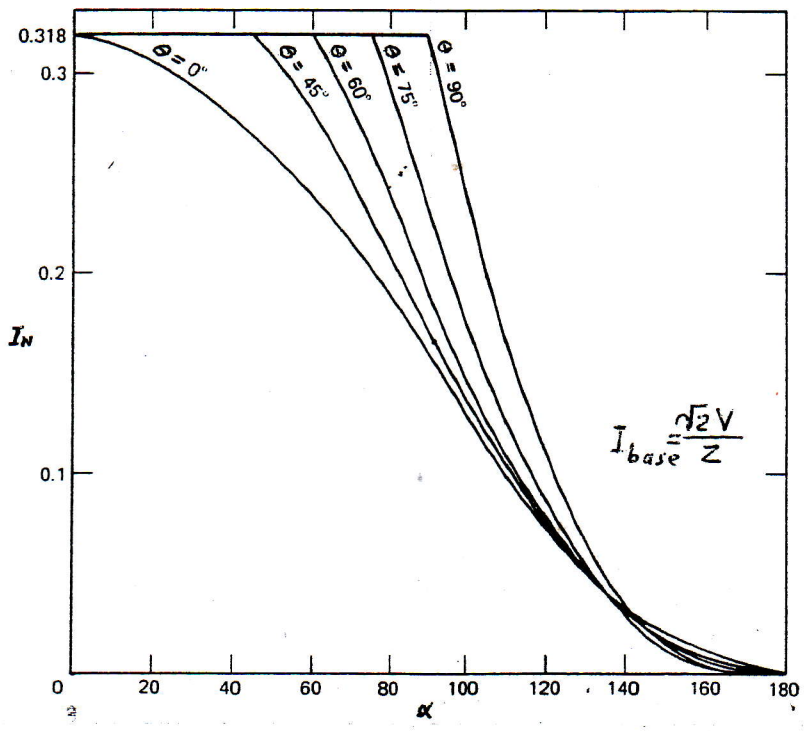

Figure (3) Normalized value of the average thyristor current (I_N) versus firing angle (α) for various load angle (ϕ).

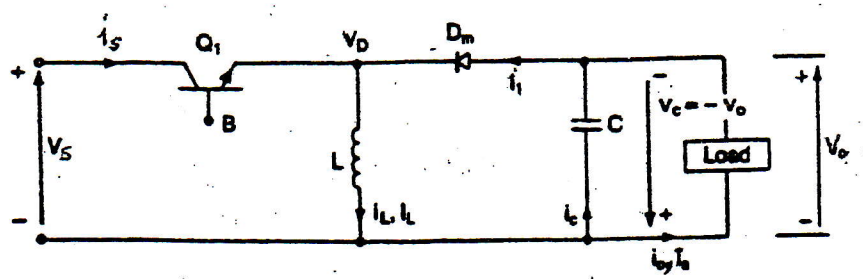

Figure (4) Buck-Boost regulator.

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