





الدراسات العليا  
Department of Electrical Engineering  
Faculty of Engineering  
Kafrelsheikh University  
2<sup>nd</sup> Semester – Final Exam  
2015/2016 - May 2016

Power and Machines Program  
Course: Power Electronics  
4<sup>th</sup> year  
Time: 3Hours  
Marks: 90

### Answer the Following Questions

#### Question no. 1 (15 points).

A single-phase ac voltage controller feeds a resistive load. The load resistance varies in the range  $0.2 \text{ ohm} < R < 0.45 \text{ ohm}$ . The rms value of the current is maintained at a constant value of 100 A by controlling the firing angle  $\alpha$ . A **single-phase transformer** is introduced between the line and two antiparallel thyristors so that at  $\alpha = 0^\circ$ , the load presents the maximum value of resistance. Assuming the value of the **supply voltage is 220 V**, Determine:

- the suitable turns ratio of the transformer (ideal). (8 points)
- the firing angle range of the ac voltage controller (7 points)

#### Question no. 2 (15 points).

A single-phase bridge inverter has an input voltage of 200V and it feeds a pure resistance of 10 ohms. Draw the waveforms of voltage and current at the load terminals. Determine (i) rms value of fundamental of the output voltage, (ii) rms and peak currents of the device, and (iii) the total harmonic distortion.

#### Question no. 3 (15 points).

The resonant pulse commutation circuit has capacitance  $C = 30 \text{ } \mu\text{F}$  and inductance  $L = 4 \text{ } \mu\text{H}$ . The initial capacitor voltage is **200 V**. Draw the circuit and determine the turn-off time of the circuit if the load current  $I_m$  is **250 A** with and without an antiparallel diode connected across the main thyristor.

#### Question no. 4 (15 points).

In a buck transistor chopper, the input dc source has a constant value  $V_s$  of 150V. The rated output power is 1 kW. The duty cycle is adjusted by the controller to keep the output voltage constant at 50V. The switching frequency is 1kHz.

- Calculate the **minimum inductance** at 10% of the rated load. (5 points)
- Calculate the capacitance if the output voltage ripple must not exceed 0.4%. Use above calculated inductance. (5 points)
- Sketch to scale the waveforms of the inductor and capacitor currents. (5 points)

#### Question no. 5 (30 points).

In the following multiple-choice questions, circle ONE best answer for each question:

- In PWM method of controlling the average output voltage in a chopper. The on-time is varied but the chopping frequency is
  - varied
  - kept constant
  - either of these
  - none of these
- A dc-dc transistor chopper supplied from a fixed voltage dc source feeds a fixed-resistive-inductive load and a free-wheeling diode. The chopper operates at 1kHz and 50% duty cycle. Without changing the value of the average dc current through the load, if it is desired to reduce the ripple content of load current, the control action needed will
  - increase the chopper frequency keeping the duty cycle constant
  - increase the chopper frequency and the duty cycle in equal ratio
  - decrease only the chopper frequency
  - decrease only the duty cycle
- In a buck transistor chopper, the input dc source has a constant value  $V_s$ . The output voltage  $V_o$  is assumed ripple-free. The transistor is operated with a switching time period  $T$  and a duty ratio  $D$ .

What is the value of  $D$  at the boundary of continuous and discontinuous conduction of the inductor current?

- (a)  $D = 1 - \frac{V_s}{V_o}$  (b)  $D = 2 \frac{L}{RT}$   
 (c)  $D = 1 - 2 \frac{L}{RT}$  (d)  $D = \frac{R-T}{L}$
- (4) An impulse commutated chopper, fed from 200V dc source, has a constant load current of 50 A. For a turn-off time of 40  $\mu$ s, the value of commutating capacitor is  
 (a) 34.7  $\mu$ F (b) 24.7  $\mu$ F  
 (c) 14.7  $\mu$ F (d) 10  $\mu$ F
- (5) In a single-phase full-wave ac voltage controller, varying the delay angle  $\alpha$  from 0 to  $\pi$  can vary the rms output voltage from  
 (a)  $V_s$  to  $V_s/4$  (b)  $V_s$  to  $V_s/2$   
 (c)  $V_s$  to  $3 V_s/2$  (d)  $V_s$  to 0
- (6) A single-phase half-wave ac voltage controller using one SCR in antiparallel with a diode, feeds 1kW, 230V heater. For a delay angle  $\alpha$  of  $180^\circ$ , the load power is  
 (a) 5 W (b) 300 W  
 (c) 400 W (d) 500 W
- (7) The conduction angle ( $\delta$ ) of SCR T1 in a single-phase full-wave ac voltage controller is obtained from  
 (a)  $\delta = \beta - \alpha$  (b)  $\delta = \beta + \alpha$   
 (c)  $\delta = \alpha - \beta$  (d)  $\delta = (\beta - \alpha)/2$
- (8) A single-phase ac voltage controller feeds an induction motor and a heater  
 (a) in both the loads only fundamental and harmonics are useful  
 (b) in induction motor only fundamental and in heater only harmonics are useful  
 (c) in induction motor only fundamental and in heater harmonics as well as fundamental are useful  
 (d) in induction motor only harmonics and in heater only fundamental are useful
- (9) If, for a single-phase half-bridge inverter, the amplitude of the output voltage is  $V_s$  and the output power is  $p$ , then their corresponding values for a single-phase full bridge inverter are  
 (a)  $V_s, p$  (b)  $V_s/2, p/2$   
 (c)  $2 V_s, 2p$  (d) none of these
- (10) A single-phase full-bridge voltage-source inverter feeds a purely inductive load. The inverter is operated in square-wave mode with a frequency of 50Hz. If the average load current is zero, what is the time duration of conduction of each feedback diode in a cycle?  
 (a) 5 m sec (b) 10 m sec  
 (c) 20 m sec (d) 2.5 m sec
- (11) A half-wave thyristor converter supplies a purely inductive load. If the triggering angle of the SCR is  $120^\circ$ , the extinction angle will be  
 (a)  $240^\circ$  (b)  $180^\circ$   
 (c)  $200^\circ$  (d)  $120^\circ$
- (12) A single-phase voltage-source square-wave inverter feeds pure inductive load. The waveform of the load current will be  
 (a) sinusoidal (b) rectangular  
 (c) trapezoidal (d) triangular
- (13) In voltage source inverters  
 (a) load voltage waveform  $V_o$  depends on load impedance  $Z$ , whereas load current waveform  $i_o$  does not depend on  $Z$  (b) both  $V_o$  and  $i_o$  depend on  $Z$   
 (c)  $V_o$  does not depend on  $Z$  whereas  $i_o$  depend on  $Z$  (d) none of these
- (14) For controlling the speed of three-phase induction motor, the method generally used is  
 (a) fixed voltage fixed frequency method (b) variable voltage variable frequency method  
 (c) fixed voltage variable frequency method (d) none of these
- (15) Armature voltage of a dc motor can be controlled by means of  
 (a) cycloconverters (b) inverters  
 (c) AC-DC converters (d) Bridge rectifier circuit with fixed input

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Best wishes  
 Tarek Ahmed; Associate Professor