UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: DEI 3053/DMT 3053
COURSE	: MOTOR CONTROL & DRIVES
SEMESTER/SESSION	: 1-2023/2024
DURATION	: 3 HOURS

Instructions:

1. This booklet contains 4 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise up your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 6 PRINTED PAGES INCLUDING COVER PAGE

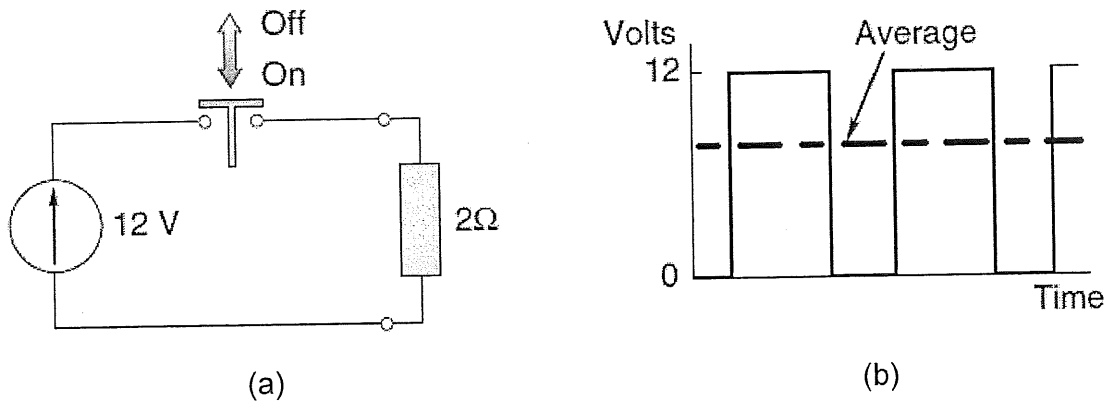
QUESTION 1

a) Define electric motor. (3 marks)

b) Define power electronic. (3 marks)

c) Draw block diagram of a motor drive system. (7 marks)

d) Figure 1(a) show the method to obtain a variable-voltage output from a constant-voltage source using switching control method. Explain the process of this method to produce the output as shown in Figure 1(b). (17 marks)



(a) (b)

Figure 1

QUESTION 2

a) Explain the function of iron core in armature winding of DC motor. (4 marks)

b) Figure 2 show the commutation action in a DC motor. Describe the process. (12 marks)

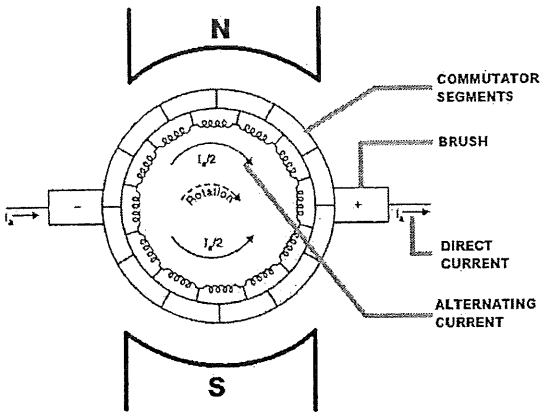


Figure 2

c) A voltage of 120 V is applied to armature of shunt DC motor results in full load line currents of 51A. Assume that armature and field resistance are 0.5Ω and 120Ω respectively. Assuming the stray losses is 250 W at full load speed of 1500rpm.

Calculate:

i. The armature current of the motor (4 marks)
ii. The back e.m.f of the motor (3 marks)
iii. The mechanical power and mechanical torque (3 marks)
iv. The output power and torque (2 marks)
v. The motor efficiency (2 marks)

QUESTION 3

a) State **three (3)** types of single-phase induction motor. (3 marks)

b) There are two types of motor in AC motor. Describe **four (4)** comparisons between induction motor and synchronous motor. (8 marks)

c) There are two types of rotor construction used for induction motor. Briefly explain:

i. Squirrel cage rotor (3 marks)
ii. Wound rotor (2 marks)

d) The full load output power to 8 pole, 50 Hz three-phase induction motor is 50kW and has a slip of 0.04 when operating at full load conditions. Assume the stator losses equal the rotor losses. The friction and windage loss are 100W.

Calculate:

i. Synchronous speed (1 marks)
ii. Rotor speed (2 marks)
iii. Mechanical power developed by the motor (2 marks)
iv. Rotor copper losses (3 marks)
v. Rotor power input (2 marks)
vi. Stator power input (2 marks)
vii. Efficiency (2 marks)

QUESTION 4

a) Classify **three (3)** differences between servo and stepper motor (6 marks)

b) Describe main advantage and disadvantage of closed-loop system respectively. (4 marks)

----------**End of question**----------

TABLE OF FORMULAS

DC Motor

DC Motor	$E_b = K_1 K_2 i_a \varpi$		
Series Motor	$V_T = E_b + i_a(R_a + R_f) + V_{brush}$		$P_{in} = V_T i_L$
Shunt Motor	$V_T = E_b + i_a R_a$ $V_T = i_f R_f$	$i_L = i_a + i_f$	$P_m = E_b i_a$
Long Shunt Compound Motor	$V_T = E_b + i_a(R_a + R_{se}) + V_{brush}$	$i_L = i_a + i_{sh}$ $i_{sh} = \frac{V_T}{R_{sh}}$	$P_{out} = P_{in} - \sum P_{loss}$ $P_{out} = P_m - P_\mu$
Short Shunt Compound Motor	$V_T = E_b + i_a R_a + i_L R_{se} + V_{brush}$ $V_{sh} = i_{sh} R_{sh}$	$i_L = i_a + i_{sh}$ $i_{sh} = \frac{V_T - i_L R_{se}}{R_{sh}}$ $i_{sh} = \frac{E_b + i_a R_a + V_{brush}}{R_{sh}}$	$\tau_m = \left(\frac{60 P_m}{2\pi N}\right)$ $\tau_o = \left(\frac{60 P_{out}}{2\pi N}\right)$ $\eta = \left(\frac{P_{out}}{P_{in}}\right) \times 100\%$

Induction Motor

$N_S = \frac{120f}{P}$	$s = \frac{N_s - N_r}{N_s} \times 100\%$	$f_r = sf$
$\tau_m = \frac{60 P_m}{2\pi N_r}$	$\tau_o = \frac{60 P_{out}}{2\pi N_r}$	$\eta = \left(\frac{P_{out}}{P_{in}}\right) \times 100\%$
$P_{in} = \sqrt{3} V_L I_L \cos\phi$	$P_{in(rotor)} = P_{in(stator)} - (P_{scu} + P_c)$	
$P_{in(rotor)} : P_{rcu} : P_m = 1 : s : 1 - s$	$P_m = P_{in(rotor)} - P_{rcu}$	$P_{out} = P_m - P_\mu$

Synchronous Motor

Synchronous motor	$N_S = \frac{120f}{P}$	$P_{in} = \sqrt{3} V_L I_L \cos\Phi$	$E_{Rph} = I_{aph} \lvert Z_s \rvert$	$Z_s = R_a + jX_s$ $Z_s = \lvert Z_s \rvert \angle\theta$
	$p.f = \cos\phi$	$P_m = P_{in} - P_{scu}$		$P_{scu} = 3{I_{aph}}^2 R_a$
	$\theta = \tan^{-1}\frac{X_s}{R_a}$	$\lvert Z_s \rvert = \sqrt{{R_a}^2 + {X_s}^2}$		$\eta = \left(\frac{P_{out}}{P_{in}}\right) \times 100\%$
	$(E_{bph})^2 = (V_{ph})^2 + (E_{Rph})^2 - 2 V_{ph} E_{Rph} \cos(\theta \pm \phi)$			