UNIVERSITY OF ESWATINI
MAIN EXAMINATION, MAY 2019

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

TITLE OF PAPER:	**ELECTRICAL DRIVES**
COURSE NUMBER:	**EE553**
TIME ALLOWED:	**THREE HOURS**

INSTRUCTIONS:

1. There are four questions in this paper. **Answer ALL questions.**
2. Each question carries its own mark as shown in all questions.
3. Marks for different sections are shown on the right hand margin.
4. Show the steps clearly in all your calculations including any assumptions made.

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THIS PAPER HAS FOUR (4) PAGES INCLUDING THIS PAGE

QUESTION 1 *(25 marks)*

a- Fig. 1 shows a motor driving two loads. Assuming there are no losses in the system, calculate the:

1- total moment of inertia of the system referred to the motor shaft. *(2-marks)*

2- total amount of torque the motor must produce to drive the load, and *(2-marks)*

3- output power of the motor. *(1-mark)*

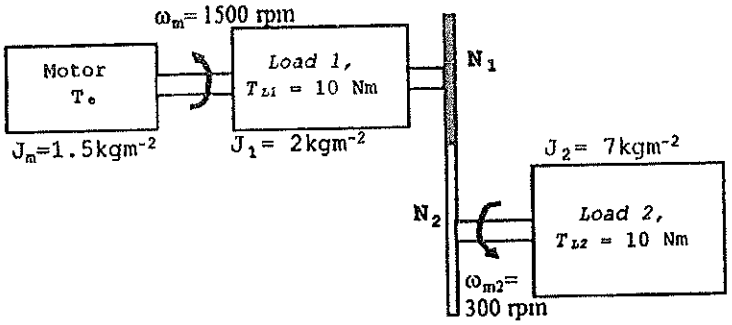

Fig. 1.

b- In Fig.2 the torque-speed characteristics of dc series excited motor with varying the armature voltage is given; explain with supports of equations:

1- how the torque-speed characteristic is behaving as shown in Fig. 2? and *(8-marks)*

2- how the torque speed characteristic is affected by varying of the supply voltage? *(2-marks)*

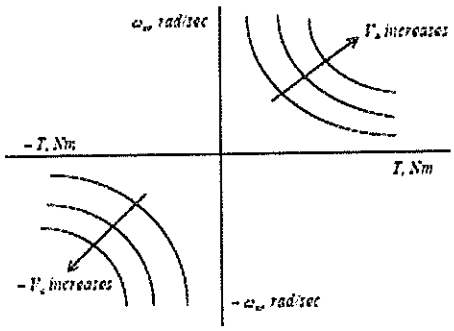

Fig. 2.

(10-marks)

c- A 220 V dc series motor drives a fan; the load torque is being proportional to the square of the speed. At a certain speed the motor draws 30 amperes from the supply, the armature resistance is 0.2 Ω and the field resistance is 0.6 Ω. Find an additional resistance inserted to the armature to reduce the speed to one-half of the running speed.

QUESTION 2 *(25 marks)*

(10-marks)

a- separately excited dc motor with armature resistance 4 Ω is connected across a single-phase full-wave controlled-rectifier, the ac mains is 230 V. The armature takes 10 A with a speed of 800 rpm at firing angle $\alpha = 30°$. Determine the speed when the armature current is 6 A and the excitation is decreased by 10 % at the same firing angle. (*given that* : $V_{dc} = \frac{Vm}{\pi}(1 + \cos\alpha)$)

b- A separately excited dc motor shown in Fig. 3, has the following parameters: R_a = 0.013 Ω, L_a = 0.01 H, J = 0.21 kgm^2, B = 1.074 x 10^{-6} Nms^2, T_L = 2.493 Nm, K_e=K_t=K_b =0.004 V/rad/s and V_a = 24 V.

1- write the dynamic equations describing the behaviour of the motor, *(5-marks)*
2- deduce the state space representation of the motor model, *(5-marks)*
3- calculate the eigenvalues $\lambda_1$and λ_2, and *(3-marks)*
4- is the motor system stable? Explain why. *(2-marks)*

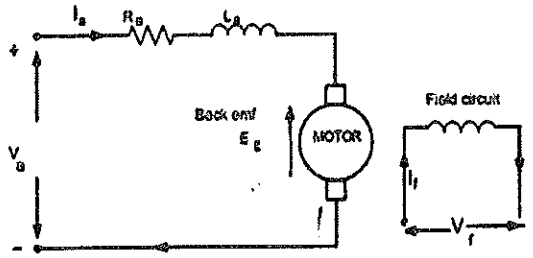

Fig. 3.

QUESTION 3 *(25 marks)*

a- There are different ways to control the speed of induction motor, some of them from the stator side and other from the rotor side. Based on what given in Fig. 4, explain the speed control method used in this technique and the positive and negative merits of this method? (Use equations, other curves, circuits, and block diagrams to enrich your explanation). *(7-marks)*

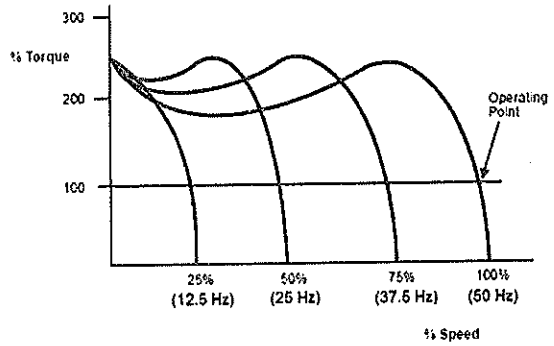

Fig. 4.

b- List three-types of the Pulse Width Modulation (PWM) method. Describe one of them and support your explanation with a simple graph. *(8-marks)*

c- Given the line-to-negative voltages V_{AN}, V_{BN}, and V_{CN} shown in Fig. 5b, for the six-step three-phase voltage source inverter, as shown in Fig. 5a, sketch the phase voltage V_{bn}. *(5-marks)*

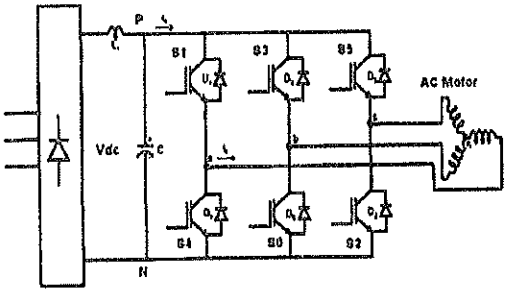

Fig. 5a

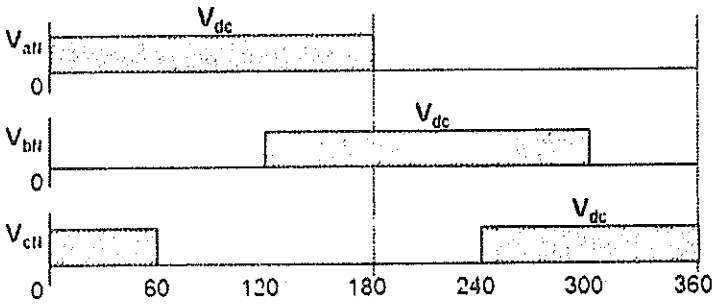

Fig. 5b.

QUESTION 4 ***(25 marks)***

(10-marks)

a- Explain in details V/F control method for induction motor drive system, as follows: the idea, types of operation (open loop and closed loop operations), and the positive and negative merits. In your explanations use block diagrams, equations and curves.

(15-marks)

b- The terminal line-line voltage of a 50 Hz, 2 poles, Y-connected induction motor is 400 V. If the motor speed is 2880 rpm, calculate the values of the following voltages at a time t = 3 msec. Then:

1- calculate V_a, V_b, and V_c (3-phase stator phases voltages),
2- calculate V_{sds} and V_{sqs} (2-phas stator voltages in stator reference frame),
3- shows that the magnitude of V_{sds} and V_{sqs} is equal to the peak value of the stator phase voltage, and
4- convert the 2-phase stator voltage V_{sds} and V_{sqs} to rotor coordinates system V_{sdr} and V_{sqr}.

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