TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY

ELECTRICAL ENGINEERING DEPARTMENT

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

TEE 4419: ELECTRICAL MACHINE DRIVES

END OF SEMESTER EXAMINATION

SERIES: NOVEMBER 2024

TIME: 2 HOURS

DATE: Pick DateSelect MonthPick Year

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass, and student ID

This paper consists of **five** Questions; Each question carries 20 marks. Attempt any THREE Questions.

Do not write on the question paper.

Question ONE

a)

i. Sketch a diagram showing classification of electric drives.

ii. State any FOUR advantages of electric drives.

(8 Marks)

b) A Flywheel with Inertia I =0.1kgm^2 is fitted to modify a lift system. Given that the original system has the following parameters:

— The rated passenger load, Q=600 kg;

— The car mass, C=100 kg;

— The counterweight balance ratio R = 40%

— Sheave diameter, d=0.7m mm;

— Gear box reduction ratio, r=50:1;

— Rated torque of the motor Ƭ= 50.0 Nm;

— Torque available for acceleration $T_a = 2T$;
— Moment of inertia of the motor rotor and the brake drum, I= 0.25 kgm^2;
— Lift speed v=2.4 m/s;
— Motor speed is N=720 rev/min.

Assume a total system efficiency of 80%, and calculate the initial linear acceleration for

i. Fully loaded forward moting.
ii. Empty loaded forward braking

(12 Marks)

Question TWO

a) State any
   i. FOUR advantages of DC Chopper Drives.
   ii. FOUR applications of DC Chopper Drives.

(8 Marks)

b) A trolley bus is driven by a DC series motor as shown in circuit Fig Q2 below:

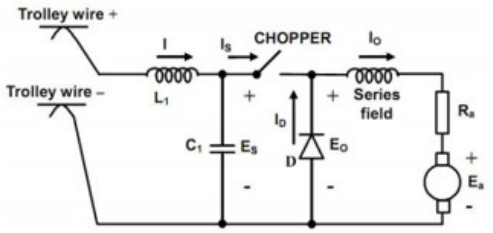

Fig Q2

The speed of the motor is controlled by a DC chopper fed by the 750V DC trolley wires. The operating frequency of the chopper is 500Hz , the ON time of the chopper 0.5 ms. The total armature circuit resistance of the series motor is 0.4Q and the current drawn by the series motor (I_o) has average value of 50A and peak-to-peak ripple of 2A. Calculate the:

i. average armature voltage (E_a),
ii. average switch current (I_s),
iii. average current of the freewheeling diode (I_d).
iv. maximum and minimum values of armature current(I_a)
v. The ON time and duty cycle of the chopper switch at starting with motor starting current limited to 100A.

(12 Marks)

Question THREE

a)

i. Sketch a AC SCR circuit.

ii. Sketch input output waveforms for the cyclo-converter in a(i) above.

(5 Marks)

a) The three-phase bidirectional controller supplies a wye-connected resistive load of 10Ω /Phase with line to line input voltage of 380V, and Frequency of 50Hz. The firing delay angle is 30^{o}. Calculate the:

i. RMS value of output Phase Voltage

ii. RMS value of Load Current

iii. RMS current of each Tyhristor

iv. Input Power Factor

(15 Marks)

Question FOUR

a)

i. Draw a 6-step, 3-phase inverter section circuit implemented using IGBT's .

ii. Sketch input output waverforms with PWM technique applied.

(6 Marks)

b) An 0.3m radius wheeled EV car has gross weight of 1500 kg. The average consumption of the car is 0.37kWh/h, and the batteries can be charged with 5kW.The battery's no-load voltage E_o ranges from 170V to 200V and its internal resistance, R_b= 0.14Ω . The Drive motor is a 2-pole three-phase, 50kW, 3000rpm, AC motor connectia via 3-phase inverter. The car has 2 gears which give speed of 120 km /hr, corresponding to net gear ratio of 1/ 2.83 to manage a 30 % uphill. Calculate:

i. Rated torque of the motor

ii. Rated stator voltage

iii. the minimum rated Transistor current

iv. gearing ratio holding for the two low gears

v. Distance of travel

(14 Marks)

Question FIVE

a)

i. Sketch a hardware implementation block diagram for 3-phase phasor switching.
ii. Explain the operation of the swithing hardware system in (i) above.

(8 Marks)

b) A two-pole permanently magnetized synchronous machine with the parameters $L_{mx}=L_{my}=L_m=15mH$ is used in an airplane and is therefore driven with stator frequencies up to 400Hz. The stator resistance is negligible. The phase current is limited to 10A RMS. DC voltage 600V feeds the motor through a converter swith. The machine needs maximum voltage (maximum current along the q-axle) and 200Hz stator frequency to develope full torque. Determine the:

i. Magnetization from permanent magnets
ii. Motor Torque.
iii. Torque at 400Hz stator frequency

(12 Marks)