THE OPEN UNIVERSITY OF SRI LANKA
DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING
DIPLOMA IN TECHNOLOGY

ECX4238 - ELECTRICAL MACHINES

FINAL EXAMINATION –2005/2006 53

Date: 10th April 2006 **Time: 0930 - 1230 hrs**

This paper contains seven questions and answer any **five (5)**. All questions carry equal marks.

Q1. Three phase 230 V, 50 Hz induction motor is to be fed from a 4000 V ac supply using a three-phase step down transformer. The electrical power required by the motor is 150 kVA at 0.85 power factor lagging.

(i). If three single-phase 60 kVA transformers are used to perform this task what should be the primary and secondary winding connection? Illustrate this using schematic diagram.

(ii). Equivalent series impedance of the each transformer referred to the low voltage side is 0.012+j0.016 Ω. Calculate the winding (LV & HV) currents of the transformer.

(iii). If secondary side voltage is 230 V, calculate the primary side voltage and voltage regulation.

Q2.(a). With the help of sketches, explain and compare the following construction features of:

(i). Shell-type and core –type of transformers.

(ii). Cylindrical and sandwich windings.

(b). A single phase 230 V/2300 V transformer is rated at 10 kVA. These two windings are electrically connected together in series (so that their voltage are additive) and form an autotransformer providing that the low voltage remains unchanged .

(i). What are the rated input and output currents before forming autotransformer ?

(ii). Calculate the transformation ratio, input and output currents of autotransformer.

(iii). Determine the increment of rating after forming autotransformer.

(iv). If the efficiency of the two winding transformer is 0.98 at rated power and 0.9 power factor lagging what would be the efficiency after connecting windings (power factor remain unchanged)?

Q3. (a). With the help of a suitable circuit diagrams, explain the star delta method of starting an induction motor.

(b). Determine the relationship between direct starting torque and delta to star starting torque. Prove same for currents.

(c). A certain three phase induction motor has the following rated values:
P=315 kW; N= 1485 rpm, η=94.5%, Cosφ=0.91, V=220 volts
When this machine is subjected to a direct starting the ratio of starting torque to nominal is 1.1 and that for the current is 7. If this motor is started using star to delta method determine the starting current and starting torque. Is it possible to start this machine with 25% of full loading?

Q4. A three phase four pole 50 Hz induction motor is subjected to an open circuit and locked rotor tests and parameters were determined using the measurement obtained. The parameters are :
R_1=0.11 Ω; R'_2 =0.08 Ω; X_1=0.4 Ω; X'_2 = 0.35 Ω; X_m=10 Ω
Line current during the locked rotor test is 80 A and no-load test done at synchronous speed.

(i). What is the input voltage at locked rotor test?
(ii). Calculate the power consumed by the machine at no-load test.
(iii). If the speed of the motor at rated speed is 1465 rpm, calculate the rated power, rotor loss and maximum torque.

Q5. A three-phase cylindrical rotor synchronous machine has following nominal parameters:
V_{line} =660 V; S=200 kVA; Cosφ=0.8; f=50 Hz

When the generator delivers nominal active power at *unity* power factor, power angle is 50^0. The field current at this situation is 72 A.

(i). Determine the synchronous reactance and emf of the generator. If saturation is neglected what is the field current at no-load condition?
(ii). Calculate the power angle when machine is operating at the nominal mode of operation.
(iii). If this machine is operating at '*underexcited*' condition with 0.9 power factor what would be the voltage behind the transient reactance.

Q6. Two generators G1 and G2 are operating in parallel to share a load of 40 MW at 0.8 power factor lagging. The output voltage of the generators are maintained at 13 kV. Synchronous impedance of G1 and G2 are 0.1+j1.0 Ω and 0.2+j1.5 Ω respectively. If both generators deliver equal reactive power and current of the first generator is 1250 A, Find:
(i). Active and reactive powers delivered by each generator.
(ii). Current through the second generator.
(iii). Power angles of the generators G1 and G2.
(iv). Draw the phasor diagram to illustrate emf and currents of G1 and G2. (Consider terminal voltage as reference)

Q7. A DC series wound machine is operating as a motor. When it is connected to the 600 V supply, a current of 180 A drawn by the motor and output power is 95 kW. The copper losses in armature and field windings are equal. Torque –current characteristic is given bellow:

T (Nm)	36	145	323	906	1294	1488
I (A)	30	60	90	180	240	270

(a). Calculate the followings for the above described motor :
(i).Efficiency
(ii).Armature and field winding resistance
(iii). Speed

(b). While input voltage and current remain as said, a resistance of same the value is connected in parallel with the field winding. Determine the speed and torque at this situation.

THE OPEN UNIVERSITY OF SRI LANKA

FACULTY OF ENGINEERING TECHNOLOGY 044

DIPLOMA OF TECHNOLOGY – LEVEL 4

Final Examination – Academic Year 2005/2006

ECX4240 - AUTOMOTIVE ELECTRONICS / ECD2220 - AUTOMOTIVE ELECTRONICS

DATE: April 19, 2006 Time: 0930 – 1230 hrs

Answer Question 1 and two others. Question 1 carries 40 marks, whereas the others each 30 marks. Each question has two parts, Part A and Part B.

IMPORTANT:

Present briefly important but relevant facts and information. Any missing information can be sensibly and reasonably assumed provided that you state them clearly. Wherever necessary, use neatly drawn sketches to explain answers.

Question 1

Part A

Refer to *Figure Q1.a* given below. Four JK flip-flops are connected for *toggling* mode with J=K=1. Observe that the interconnections between flip-flops consist of only following:

The output A of the first flip-flop FF1 in the right being connected to the clock input of FF2

The output of each FF is connected to the clock of the next FF. For example the output B of FF 2 is connected to the clock input of FF3. The given input signal, which is a square, is applied to the clock of FF1. The flip-flops toggle on the negative-going transition of the waveform.

It is assumed that all Flip-flops (FF) are initially RESET.

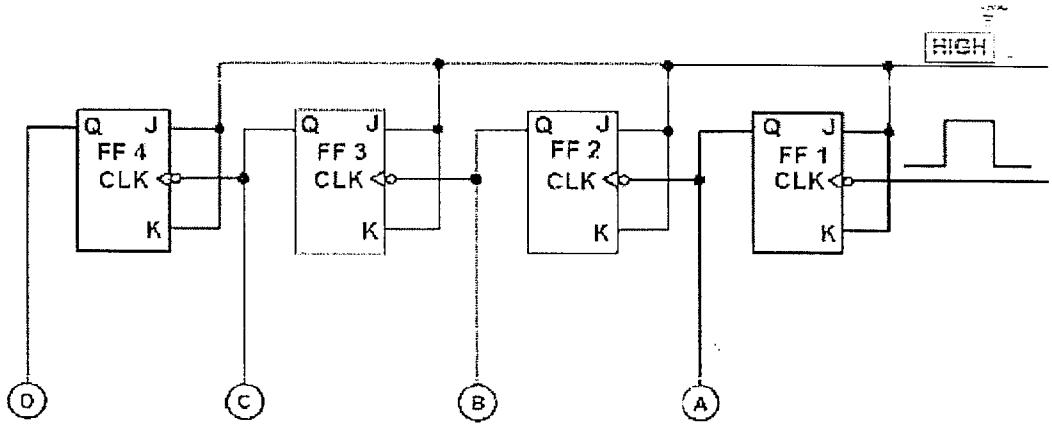

Figure Q1.a

i. What type of circuit is shown in the *Figure Q1.a*?

ii. Draw the waveforms at the clock ("CLK" in first flip-flop "FF1") input and at the flip-flop outputs A, B, C and D.

iii. At a given instant if all flip-flop outputs are in "ON" state (Logic high), which outputs are in "ON" state after 16 input pulses?

iv. What is the main disadvantage of using the above circuit with a high frequency input?

(20 Marks)

Part B

i. What are the major characteristics of ideal OP amp?

ii. In the circuit given in *Figure Q1.b1*, what is the expression for the ratio of output to input voltages (V_{out} / V_{in})?

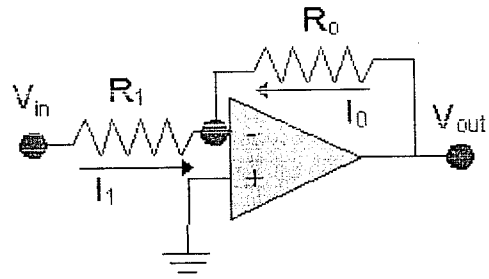

Figure Q1.b1

iii. What is the function of a comparator?

iv. Draw the output waveform of the comparator circuit shown in *Figure Q1.b2* when the input signal (V_{in}) and reference voltage (Vref) as given in the *Figure Q1.b3*.

(20 Marks)

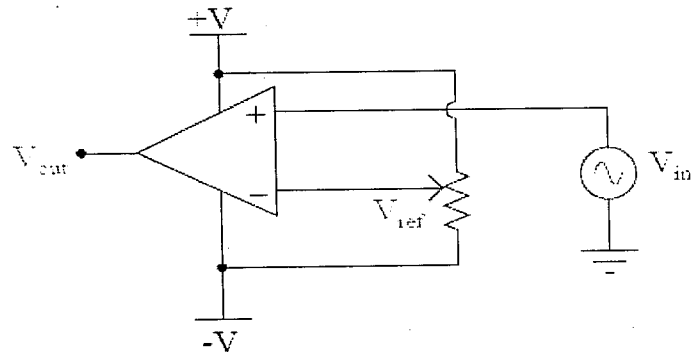

Figure Q1.b2

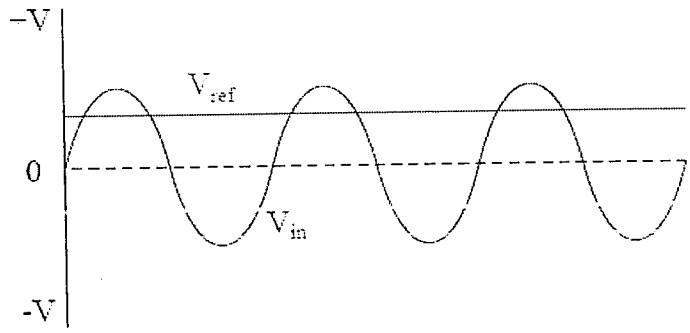

Figure Q1.b3

Question 2

Part A

i) Briefly describe the function of any three of the following sensors:

Air Flow sensor	Oxygen sensor
Temperature sensor	Throttle Position sensor
Pressure sensor	Acceleration sensor

ii) Modern automobiles use polymer **P**ositive **T**emperature **C**oefficient (PTC). What are the specific applications in an automobile where these PTCs can be used as circuit breakers?

(15 Marks)

Part B

i) What are the three major components of the charging system of an automobile?

ii) What is the major function of the alternator? Name and identify the major components inside an alternator?

iii) 'The regulator is the brain of the charging system.' What is the function of the regulator in this system?

iv) What is the function of the diode bridge in the charging system?

(15 Marks)

Question 3

Part A

Computer control systems continually monitor the operating conditions of modern vehicles. Computers through sensors receive information on several variables to be monitored, and computers use the sensed data to control different systems on a vehicle through the use of actuators. Such systems facilitate minor adjustments to be made far quicker and more accurate than those mechanical systems.

i. List two types of **actuators** and provide an example of each.

ii. Describe the basic operation of a **stepper motor** and how they are used.

iii. Explain two ways by which **solenoids** can be controlled.

iv. Explain the operation of a **Reed switch** and how they are used.

(15 Marks)

Part B

Relays that come in assorted sizes, ratings, and applications, are used as remote control switches in many areas of an automobile. A typical vehicle can have 20 relays or more.

i. Why are voltage-spikes a problem with relays? Explain how the spike is created.

ii. Explain how voltage suppression is controlled in a relay. Provide a sketch of each type.

iii. Describe the step-by-step procedure to be followed in identifying the type of the relay when it is not labeled or unknown.

iv. Explain how you check the condition (good or bad) of the suppression diode inside the relay.

(15 Marks)

Question 4

Part A

In automobiles, knock sensors are used to detect engine knock and send a voltage signal to the **E**lectronic **C**ontrol **M**odule (ECM).

i. Explain the operation of the knock sensor?

ii. Name three possible locations where this sensor can be installed to detect the engine knock.

iii. How do you analyze the output of a knock sensor?

iv. Plot the typical output voltage pattern with respect to the frequency, when knock occurs.

(15 Marks)

Part B

Tachometer is simply a means of counting the engine revolutions of an automobile engine. *Figure Q4.b1*, shows a circuit with a 555-timer *(Figure Q4.b2)*, which has been configured as a monostable or one-shot multivibrator. It can be used as a circuit for a tachometer. The 50 mA DC meter of the tachometer receives calibrated current when the 555-timer output is high. After the timer has timed out, the tachometer meter movement receives no further current during that part of the duty cycle. Integration of the variable duty cycle produces a visible indication of the engine speed.

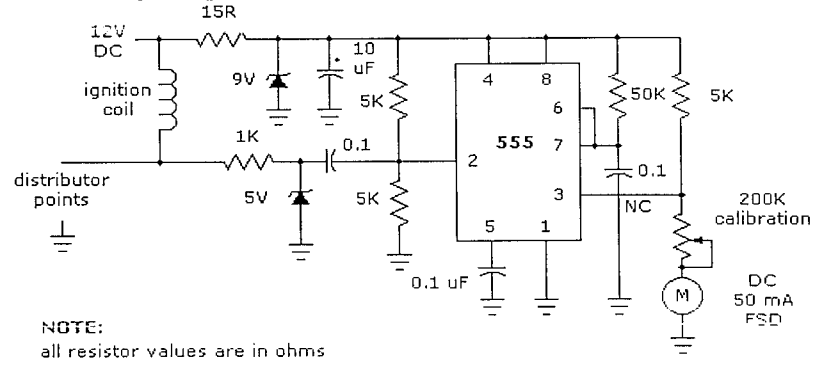

Figure Q4.b1

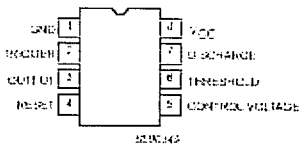

Figure Q4.b2

i. What is the regulated voltage supplied to the 555-timer in this circuit?

ii. Calculate the output pulse duration of the above circuit.

iii. Explain the Triggering of the above timer. How is the 555-timer triggered?

iv. What is the function of zener diodes and the variable resistor labeled as "200K calibration" in the circuit diagram?

(15 Marks)

Question 5

Part A

Controller Area Network (CAN) is the state of the art technology for in-vehicle networks. In the past, automotive manufacturers connected electronic devices in vehicles using point-to-point wiring systems. Manufacturers began using more and more electronics in vehicles, which resulted elimination of bulky wire harnesses that were heavy and also costly. Later the dedicated wiring were replaced by in-vehicle networks, which reduced wiring cost, complexity, and weight.

i. What type of bus system is used in CAN?

ii. In what systems of a vehicle is the CAN used?

iii. Explain the benefits of using the CAN.

iv. CAN was first created for automotive applications. What are the other typical applications of CAN?

(15 Marks)

Part B

Sensors that sense pressure are common in automobiles. They can be used to measure pressure at the intake manifold, of the atmosphere, of vapor in the fuel tank, etc. Intake manifold pressure is measured by using a pressure sensor called Manifold Absolute Pressure (MAP) sensor.

i. Explain the operation of the MAP sensor.

ii. Why does the Electronic Control Module (ECM) need to know the MAP sensor signal?

iii. How do you detect a faulty MAP sensor?

iv. Why do we need to know the specific voltage drop at different pressures?

(15 Marks)