UNIVERSITY OF SWAZILAND

MAIN EXAMINATION 2004/2005

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRONIC ENGINEERING

TITLE OF PAPER: ELECTRONIC SYSTEM DESIGN

COURSE CODE: E330

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1. There are five questions in this paper. Answer Question ONE and any other THREE questions.
2. Question one carries 40 marks while the other questions each carry 20 marks.
3. If you think not enough data has been given in any question you may assume any reasonable values.
4. Linear graph paper is provided.

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR

THIS PAPER CONTAINS SEVEN (7) PAGES INCLUDING THIS PAGE

QUESTION 1 (COMPULSORY) ***(40 marks)***

Answer all ten parts of this question. Only short answers (up to half a page) are expected.

(a) (i) Draw a simple equivalent circuit of a real capacitor and sketch its reactance as a function of frequency. *(3 marks)*

(ii) A capacitor of 1 nF has a stray inductance of 0.025 μH. Suggest a range of frequencies over which this capacitor may be used. *(2 marks)*

(b) Show that the effective inductance L_{eff} of a real inductor having an inductance L, a series resistance R and a parallel parasitic capacitance C is as stated below, when $\omega L \gg R$:

$$L_{eff} = \frac{L}{1-\left(\frac{\omega}{\omega_o}\right)^2}, \quad \text{where } \omega_o^2 LC = 1. \qquad \textit{(4 marks)}$$

(c) A resistor has a nominal value of 1.2 kΩ at 20 °C. State three factors that can cause this resistor to have a value different from its nominal value. *(3 marks)*

(d) A portable transmitter used by a security guard consumes 3 W at 12 V when transmitting and 0.5 W at 12 V when receiving. The unit operates from a rechargeable battery. The guard works over an 8 hour shift, 30 minutes of which is spent transmitting. What battery capacity (in Ah) is required and what assumptions have you made in your answer? *(5 marks)*

(e) Briefly outline the reasons why most electronic systems are designed and built in the modular form. *(3 marks)*

(f) Wires of 0.5 m are used to connect a 5 V power supply to a circuit taking 6A current. The wire is 7/0.2 PTFE insulated copper wire and the resistivity of copper is 1.7×10^{-8} Ωm. Find the voltage appearing at the supply terminals of the circuit. *(4 marks)*

(g) You are asked to compare two secondary battery technologies for use in portable equipment such as a cell phone or laptop computer. Briefly discuss the important parameters or factors you would use in the comparison. *(5 marks)*

(h) Describe the meaning of the terms R(t) and λ in the reliability equation

$$R(t) = e^{-\lambda t}$$ *(4 marks)*

(i) What is the difference between hard and soft magnetic materials? How do their B-H curves differ? *(3 marks)*

(j) What type of **cable** and **connector** would be suitable for the following applications?

1) A 100 MHz connection between a signal generator and an oscilloscope.

2) A connection between a stereo microphone and a tape recorder.

Explain why the components you suggest would be appropriate in each case.

(4 marks)

QUESTION TWO ***(20 marks)***

(a) A 100 VA transformer is supplied from 220 V, 50 Hz mains. The transformer core has a cross-section of 640 mm^2. The secondary voltage is 15 V r.m.s.

i) If the flux density in the core is not to exceed 1.25 Tesla, determine the number of turns of the transformer windings. *(6 marks)*

ii) Calculate the maximum primary and secondary current of the transformer. *(2 marks)*

iii) Explain why the core of such a transformer is made from steel laminations instead of a solid steel block. *(2 marks)*

(b) The simple zener diode shunt regulator circuit in Fig. Q.2b supplies 12 V from a 15 V unregulated supply. The 12 V zener diode is rated at 500 mW and has a minimum operating current of 5 mA. Assume that the zener diode has zero slope resistance, zero temperature coefficient and no self heating.

(i) Select a value for R. *(3 marks)*

(ii) Determine the maximum allowable load current. *(2 marks)*

(iii) What is the efficiency of the circuit at maximum load current and when supplying 5 mA? *(3 marks)*

(iv) What is the main draw back with this simple regulator circuit? *(2 marks)*

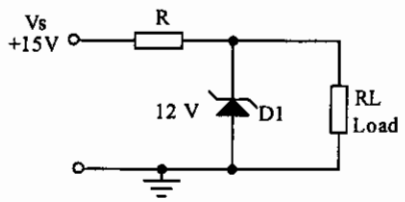

Fig Q.2b

QUESTION THREE ***(20 marks)***

A full-wave rectifier power supply is to be designed to have the following operation parameters:

Peak rectified voltage	=	20.2 V
Supply voltage	=	220 V, 50 Hz
Load current	=	2 A
Maximum ripple voltage	=	1.5 V peak-to-peak

Determine:

a) The VA and secondary voltage rating of the transformer. *(5 marks)*

b) The value and voltage rating of the smoothing capacitor. *(8 marks)*

c) The peak current ratings of the rectifier diodes. *(7 marks)*

QUESTION FOUR ***(20 marks)***

(a) (i) What is the significance of Mean Time To Repair (MTTR) in the context of maintenance of electronic equipment? *(2 marks)*

(ii) Briefly discuss **five** factors that affect MTTR of equipment. *(10 marks)*

(b) The base station for a mobile radio system has a triplicated transmitter system with the three similar transmitter units permanently connected in parallel. If one of the three transmitter units fails, the probability of a mobile user maintaining contact with the base station is 0.45; if more than one unit fails the base station is considered to be off-air. What is the probability of a mobile user maintaining contact with the base station over a 24 hour period if each of the three base station transmitter units has a MTBF of 24000 hours? *(8 marks)*

QUESTION FIVE ***(20 marks)***

A signal from a 600 Ω microphone is fed into a three stage amplifier via a microphone cable of capacitance 9 pF/m. The amplifier stages are directly coupled to each other and are identical. Each amplifier stage has input resistance 1 kΩ, output resistance 150 Ω and voltage gain 50 V/V. The final stage of the amplifier is capacitively coupled to a load of 100 Ω. If microphone generates a 1 mV r.m.s. signal, and the lower and upper cut-off frequencies of the system are desired to be 100 Hz and 10 kHz respectively, determine:

a) The signal appearing at the load. *(10 marks)*

b) The maximum length of microphone cable that may be used. *(6 marks)*

c) The value of the load coupling capacitor. *(4 marks)*