The University Of Sheffield.

Data Provided: None

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2006-2007 (2 hours)

Systems Engineering

Answer **THREE** questions. **No marks will be awarded for solutions to a fourth question.** Solutions will be considered in the order that they are presented in the answer book. Trial answers will be ignored if they are clearly crossed out. **The numbers given after each section of a question indicate the relative weighting of that section.**

1. **a.** Explain the system testing process and, where relevant, draw parallels with the system hierarchy. Use diagrams in your explanation. **(4)**

b. Explain what a test plan is and why it is required. Highlight the main features of a test plan. **(4)**

c. You have just developed a passive LC low-pass filter. The filter is to be used at the input of a mains-based power supply in an attempt to reject unwanted disturbances such as voltage spikes. Explain what tests you would perform to ensure your filter design is adequate for its assigned task. **(3)**

d. Explain what a bed-of-nails tester is and how it is used. **(3)**

e. With reference to digital systems, explain what is meant by the term combinational explosion. Briefly describe what special measures should be taken to ensure digital systems can be comprehensively tested. **(3)**

f. Explain what a boundary scan test is, and how it is used. **(3)**

2. You work for a small consultancy firm specialising in microprocessor-based solutions for industry. A client asks you to develop a data processing system to measure the weight loading that vehicles present on a bridge at 14 predefined locations. They issue you with the following requirements:

- Measurements should be discretised locally and transmitted to a central supervisor computer.
- Each weight transducer (load cell) provides a uni-polar analogue voltage of 50mV maximum.
- Weight transducer sensitivity is 0.1μV/kg.
- Local data acquisition systems (LDASs):
  - Maximum frequency of interest is 10Hz
  - Send the average measurement to the supervisor using a proprietary wireless network
  - Use a dedicated analogue-to-digital converter (ADC) IC for measurement conversion which has a reference voltage of 5V.
- Supervisor computer (SC):
  - Display all measurements on a display console in the bridge control office.
  - Log the measurements with a time/date stamp
  - Display time-averaged measurements on a web-page

From the specification:

a. Draw a block diagram representing features of the LDAS from input to output. On the same diagram indicate signal types. **(4)**

b. Determine the minimum sample frequency for the local system. **(1)**

c. What resolution should the ADC have if the weight measurements are to be accurate to at least 250kg. **(2)**

d. Identify the main software operations that the LDAS should perform. Draw a flowchart featuring these operations. **(4)**

e. Draw a block diagram of the SC system **(4)**

f. Identify the main software operations that the SC should perform. Write pseudo code featuring these operations. **(5)**

3. **a.** Determine the reliability of the system depicted in Figure 3.1 for an operating time of 3500hours.

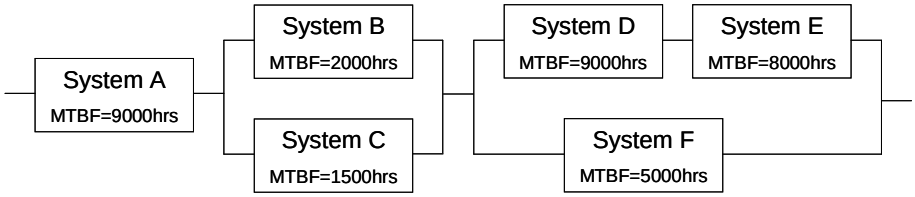

Figure 3.1 **(5)**

b. With reference to the Arrhenius equation, describe how it is possible to increase the speed with which reliability measurements can be taken. **(3)**

Table I contains reliability performance data for an integrated power module (IPM). This data was obtained by testing 1000 IPMs under a specified condition. Using data from this table:

c. Plot failure rate as a function of time on the supplied graph paper. **(5)**

d. Explain what is meant by the bath tub curve. On your plot from part c. label the infant mortality period, normal operating period and wear-out period. **(5)**

e. From your reliability plot estimate the IPM's average failure rate during the normal operating period using a line of best fit. **(1)**

f. Assuming an IPM has been operated through a burn-in period, determine the reliability of an IPM if it was to operate for 2,160 hours (approx. 3 months). **(1)**

Time (100,000 hours)	IPMs surviving
0	1000
1	860
2	792
3	743
4	701
5	663
6	599
7	531
8	485
9	426
10	384
11	326
12	261
13	161

Table I

4. **a.** Draw and explain the elements of tree system hierarchy for a generic system. Expand on these ideas by drawing the hierarchy diagram for a mobile phone. **(7)**

b. Explain what is meant by abstraction and describe how it can be used in a generic systems engineering context. **(2)**

c. Using the high-pass filter shown in Fig. 4.1 show how abstraction can be applied to system modeling by deriving a transfer function representing the ratio of output voltage to input voltage (V_{out}/V_{in}) in terms of a the corner frequency parameter $\omega_c = \frac{1}{CR}$.

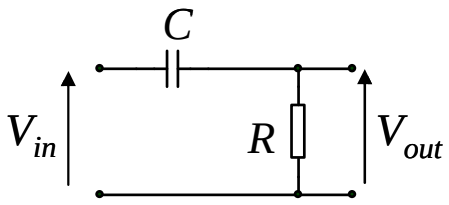

Figure 4.1 **(3)**

d. With the aid of diagrams describe a system's life cycle and its relation to the waterfall model. Include a detailed description of the waterfall model in your answer. **(5)**

e. Explain how the Waste Electrical and Electronic Equipment (WEEE) Directive and Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations (ROHS) affect the systems engineering process. In your answer state which phases in particular are likely to be the most affected. **(3)**

MPF / CMB