S5 DAT Practice Paper I Drawing scale, tolerances, RC circuits, cooling and 3D printing costs

S5 DAT I Time allowed: 75 minutes I Total: 100 marks I 24 questions

Part A Projection drawing, scale and sheet capacity

Question 1 (16 marks)

1. A part 2 400 mm long is drawn at a scale of 1:20. Find its length on the drawing in mm. (4 marks)

2. A plan is drawn at 1:50 and the area on paper is 84 cm2. Find the actual area in m2. (5 marks)

3. The usable drawing area is 400 mm by 280 mm at a scale of 1:10. Find the largest diameter that can be drawn in full, in m. (4 marks)

4. A part is drawn at 2:1 and measures 150 mm on paper with a tolerance of +/-0.4 mm marked. Find the real length and real tolerance in mm. (3 marks)

Part B Tolerances, fits and fasteners

Question 2 (15 marks)

5. A hole is 24.000 to 24.021 mm and the shaft is 23.979 to 24.000 mm. Find the maximum and minimum clearance in mm and name the class of fit. (5 marks)

6. For the same limits, find the tolerance zone of the hole and of the shaft in mm and say whether they are equal. (4 marks)

7. At a basic size of 30 mm, IT7 is 21 micrometres and IT8 is 33 micrometres. Find the ratio of IT8 to IT7. (3 marks)

8. In a batch of 200 parts the reject rate is 2% and each good part earns $45. Find the number of good parts and the total profit. (3 marks)

Part C RC charging and LED circuits

Question 3 (18 marks)

9. A resistor of 10 kohm is in series with a 470 microfarad capacitor. Find the time constant in seconds. (4 marks)

10. A 9 V supply charges the capacitor through the resistor. Find the capacitor voltage at one time constant and the time taken to reach it. (5 marks)

11. Find the time for five time constants in seconds and state roughly what percentage of full charge has been reached. (4 marks)

12. A 5 V supply drives an LED with a forward drop of 2.1 V at 20 mA. Find the series resistor in ohms and the power it dissipates in mW. (5 marks)

Part D Capacitor energy and battery capacity

Question 4 (16 marks)

13. A 470 microfarad capacitor is charged to 9 V. Find the stored energy in mJ to three significant figures. (4 marks)

14. If the voltage is raised to 18 V, what is the stored energy in mJ, and why? (4 marks)

15. A 12 V, 2000 mAh battery is discharged at a constant 0.5 A. Find the running time in hours and the total energy in Wh. (4 marks)

16. The same battery has a discharge efficiency of 85%. Find the usable energy in Wh and in J. (4 marks)

Part E Heat sinks, thermal resistance and power

Question 5 (17 marks)

17. A component dissipates 5 W with a thermal resistance of 6 degC per W in a 30 degC environment. Find the temperature rise and the component temperature. (5 marks)

18. With a heat sink the thermal resistance falls to 2.5 degC per W while dissipation rises to 8 W at the same 30 degC ambient. Find the new temperature. (4 marks)

19. If the maximum junction temperature is 85 degC, the ambient is 35 degC and the dissipation is 6 W, find the largest allowable thermal resistance in degC per W. (4 marks)

20. A cooling fan draws 0.15 A at 12 V while the chip dissipates 8 W. Find the fan power in W and its percentage of the chip dissipation. (4 marks)

Part F 3D printing cost and pricing

Question 6 (18 marks)

21. A model has a volume of 12 cm3 and PLA has a density of 1.24 g/cm3. Find the mass of filament used in g. (4 marks)

22. Filament costs $180 per kg. Find the material cost of that model in dollars to two decimals. (4 marks)

23. Printing takes 2.5 hours at $12 per machine hour, plus 10% extra material for failed prints. Find the total cost to two decimals. (5 marks)

24. To achieve a 35% gross margin, find the selling price in dollars to two decimals. (5 marks)