

1. Using the method of exhaustive proof show whether $\overline{a(b+c)}$ is equal to $\bar{a} + \bar{b}\bar{c}$. 3 marks
2. Draw the simplest logic gate or circuit for the following descriptions. The inputs are a, b, c . The output is z . 4 marks
 - (a) $z = 1$ only if $abc = 101$
 - (b) $z = 0$ unless $abc = 011$
 - (c) $z = 0$ only if “ $abc = 010$ or $abc = 110$ ”
3. Simplify the following 6 marks
 - (a) $B\bar{A} + (E + F)BC + BC + CA$ to 4 literals
 - (b) $(X + W)(Y + Z) + XYW$ to 4 non-repeating literals
 - (c) $X\bar{Y} + XZ + \bar{Z}Y$ to 3 literals
4. Prove algebraically that $(\bar{a} + \bar{b})(\bar{b} + \bar{c})(\bar{c} + \bar{a}) = \bar{a}\bar{b} + \bar{b}\bar{c} + \bar{c}\bar{a}$ 2 marks
5. Convert the expression $\overline{a + (\bar{d} + a)cg}$ to a form where the bar is over single variables only. 2 marks
6. Prove or disprove that the function $Z = ab + c(a + b)$ is self-dual. Note that self-dual functions satisfy the property $\overline{f(a, b, c)} = f(\bar{a}, \bar{b}, \bar{c})$. 3 marks