LOGIC CIRCUIT (TYPE III)

- Produce truth table for this data;

A wind turbine has a safety system which uses three inputs to a logic circuit. A certain combination of conditions results in an output, X, from the logic circuit being equal to 1. When the value of X = 1 then the wind turbine is shut down.

The following table shows which parameters are being monitored and form the three inputs to the logic circuit.

Parameter description	Parameter	Binary value	Description of condition
turbine speed	S	0	<= 1000 rpm
		1	> 1000 rpm
bearing temperature	T	0	<= 80°C
		1	> 80°C
wind velocity	W	0	<= 120 kph
		1	> 120 kph

The output, X, will have a value of 1 if any of the following combination of conditions occur:

- **either** turbine speed <= 1000 rpm and bearing temperature > 80°C
- **or** turbine speed > 1000 rpm and wind velocity > 120 kph
- **or** bearing temperature <= 80°C and wind velocity > 120 kph.

LOGIC CIRCUIT (TYPE III)

Parameter description	Parameter	Binary value	Description of condition
turbine speed	S	0	<= 1000 rpm
		1	> 1000 rpm
bearing temperature	T	0	<= 80°C
		1	> 80°C
wind velocity	W	0	<= 120 kph
		1	> 120 kph

- Step 1, convert three statements into logic statements

i turbine speed <= 1000 rpm and bearing temperature > 80°C
logic statement: (S = NOT 1 AND T = 1)

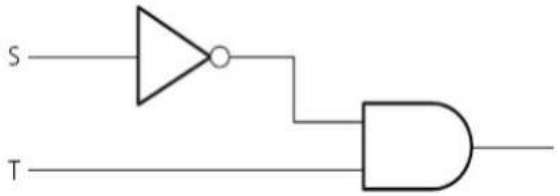
ii turbine speed > 1000 rpm and wind velocity > 120 kph
logic statement: (S = 1 AND W = 1)

iii bearing temperature <= 80°C and wind velocity > 120 kph
logic statement: (T = NOT 1 AND W = 1)

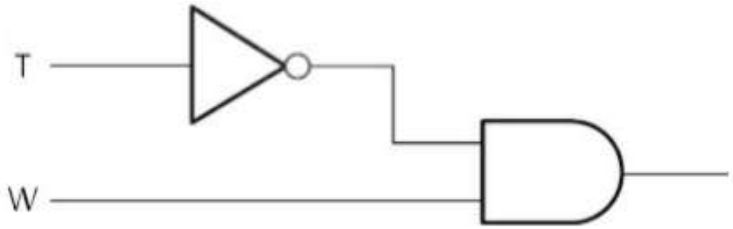
LOGIC CIRCUIT (TYPE III)

- Step 2, produce logic circuits from logic statements

i turbine speed <= 1000 rpm and bearing temperature > 80°C
logic statement: (S = NOT 1 AND T = 1)



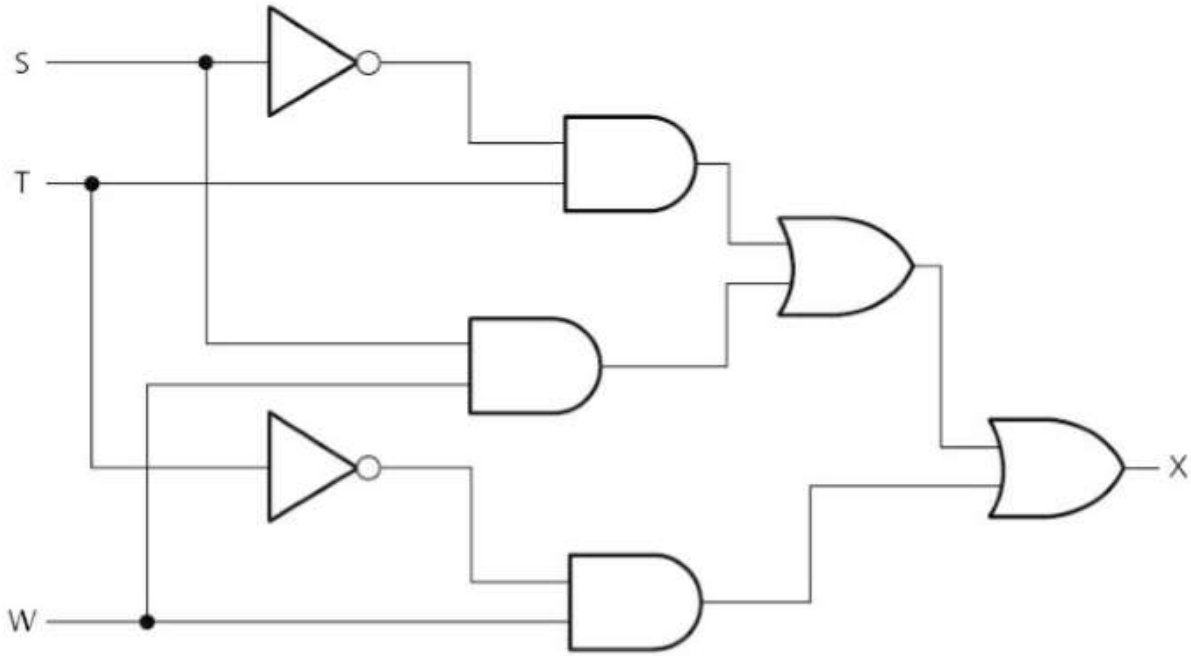
iii bearing temperature <= 80°C and wind velocity > 120 kph
logic statement: (T = NOT 1 AND W = 1)



ii turbine speed > 1000 rpm and wind velocity > 120 kph
logic statement: (S = 1 AND W = 1)

LOGIC CIRCUIT (TYPE III)

- Step 3, join the logic circuits together with OR gates



LOGIC CIRCUIT (TYPE III)

- Produce truth table

Inputs			Intermediate values				Output
S	T	W	(i) (S=NOT 1 AND T=1)	(ii) (S=1 AND W=1)	(iii) (T=NOT 1 AND W=1)	(iv)	X
0	0	0	*0*	*0*	*0*	*0*	0
0	0	1	*0*	*0*	*1*	*0*	1
0	1	0	*1*	*0*	*0*	*1*	1
0	1	1	*1*	*0*	*0*	*1*	1
1	0	0	*0*	*0*	*0*	*0*	0
1	0	1	*0*	*1*	*1*	*1*	1
1	1	0	*0*	*0*	*0*	*0*	0
1	1	1	*0*	*1*	*0*	*1*	1

a A chemical process is protected by a logic circuit. There are three inputs to the logic circuit representing key parameters in the chemical process. An alarm, X, will give an output value of 1 depending on certain conditions in the chemical process. The following table describes the process conditions being monitored:

Table 3.16

Parameter description	Parameter	Binary value	Description of condition
chemical reaction rate	R	0	reaction rate < 40 mol/l/sec
		1	reaction rate >= 40 mol/l/sec
process temperature	T	0	temperature > 115°C
		1	temperature <= 115°C
concentration of chemicals	C	0	concentration = 4 mol
		1	concentration > 4 mol

An alarm, X, will generate the value 1 if:
either
reaction rate < 40 mol/l/sec
or
concentration > 4 mol AND temperature > 115°C
or
reaction rate >= 40 mol/l/sec AND temperature > 115°C

R	T	C							
0	0	0							
0	0	1							
0	1	0							
0	1	1							
1	0	0							
1	0	1							
1	1	0							
1	1	1							

b A power station has a safety system controlled by a logic circuit. Three inputs to the logic circuit determine whether the output, S, is 1. When S = 1 the power station shuts down.
The following table describes the conditions being monitored.

Table 3.17

Parameter description	Parameter	Binary value	Description of condition
gas temperature	G	0	gas temperature <= 160°C
		1	gas temperature > 160°C
reactor pressure	R	0	reactor pressure <= 10 bar
		1	reactor pressure > 10 bar
water temperature	W	0	water temperature <= 120°C
		1	water temperature > 120°C

Output, S, will generate a value of 1, if:
either
gas temperature > 160°C AND water temperature <= 120°C
or
gas temperature <= 160°C AND reactor pressure > 10 bar
or
water temperature > 120°C AND reactor pressure > 10 bar

G	R	W							
0	0	0							
0	0	1							
0	1	0							
0	1	1							
1	0	0							
1	0	1							
1	1	0							
1	1	1							