Name of the Student:_____
Max. Marks : 22 Marks **Time : 22 Minutes**

Mark Schemes

Q1.

(a) Difference: BCD counter outputs binary codes. A Johnson decade counter outputs a single output sequentially✔

Similarity: Both counters recycle at the 10th pulse ✔
Both outputs described.
Condone – max counter value for 10th pulse.
Accept: both counters count from 0–9
OR both counters count to 10

2

(b) Duty cycle:

From oscilloscope t_{on} = 3 div @ 50 µs / div = 150 µs
OR
t_{off} = 2 div @ 50 µs / div = 100 µs ✔

$$\frac{t_{on}}{(t_{on} + t_{off})} \times 100 = 60\% \quad \text{OR} \quad 0.6 \quad ✓$$

(accept 'divisions' to signify the values of t_{on} and t_{off})

Frequency:

From CRO t_p = 5 div @ 50 µs / div
t_p = 250 µs

$f = 1/t_p$ = 4 kHz ✔
Only 1 mark for:
either of t_{on} or t_{off} correct but duty cycle wrong
OR
correct use of both wrong t_{on} and t_{off}
One mark for:
correct use of their t_{on} + t_{off}

3

(c) **BCD:** Q_2 = 600 / 10 = 60 Hz ✔

(only one pulse is produced in 10 clock pulses at Q_2)

Johnson: Q_2 = 600 / 10 = 60 Hz ✔

[7]

Q2.

The mark scheme gives some guidance as to what statements are expected to be seen in a 1 or 2-mark (L1), 3 or 4-mark (L2) and 5 or 6-mark (L3) answer.

Level	Criteria
L3 6 marks	Candidate matches the **three** areas of the communications spectrum with the correct pathway. They provide a coherent and comprehensive explanation of the properties of each pathway. The answer has structure and detail.
L3 5 marks	Candidate matches the **three** areas of the communications spectrum with the correct pathway. They provide a comprehensive explanation of the properties of each pathway, but the answer may lack structure / detail.
L2 4 marks	Candidate matches **two** areas of the communications spectrum with the correct pathway. They provide a coherent and comprehensive explanation of the properties of each pathway. The answer has structure and detail.
L2 3 marks	Candidate matches the **two** areas of the communications spectrum with the correct pathway. They provide a comprehensive explanation of the properties of each pathway, but the answer may lack structure / detail.
L1 2 marks	Candidate matches **one** area of the communications spectrum with the correct pathway. They provide a coherent and comprehensive explanation of the properties of that pathway. The answer has some structure and detail.
L1 1 mark	Candidate matches **one** area of the communications spectrum with the correct pathway. They provide some explanation of the properties of the pathway. The answer may lack structure / detail.
L1 0 marks	The work contains no significant analysis of the question asked.

Longwave
Typical frequency range
Broadcasts between 150 kHz – 300 kHz which fits into the LF band.
Also accept extended (3 kHz – 500 kHz) range to allow for special applications.
Pathway – Ground (surface waves)

i. Generally, line of sight.
ii. Beyond the horizon communication by following earth's curvature.

iii. Diffraction in the atmosphere due to different refractive index.
iv. Diffraction due to interaction of the wave with conductive surface (earth).
v. Diffraction due to interaction with geographical topography – hills / buildings.
vi. Long distance propagation due to low attenuation of low frequency waves.
vii. Transmission severely attenuated by ionosphere so little reflection

Shortwave
Typical frequency range
Normally taken as 3 MHz – 30 MHz which includes the full HF band. (Accept lower limit of 1.7 MHz)
Pathway – Sky waves

i. Ionosphere acts to refract and hence reflect waves back to the earth.
ii. This allows beyond the horizon reception due to single/multiple reflections (skips).
iii. Below this frequency, ionosphere will absorb waves.
iv. Above this frequency, the wave will pass through the ionosphere.
v. Can suffer disruption due to the state of the ionosphere day/night effects or sunspot cycle.

Microwaves
Typical frequency range
Normally taken as 2 GHz – 100 GHz Accept 1.7 GHz – 300 GHz

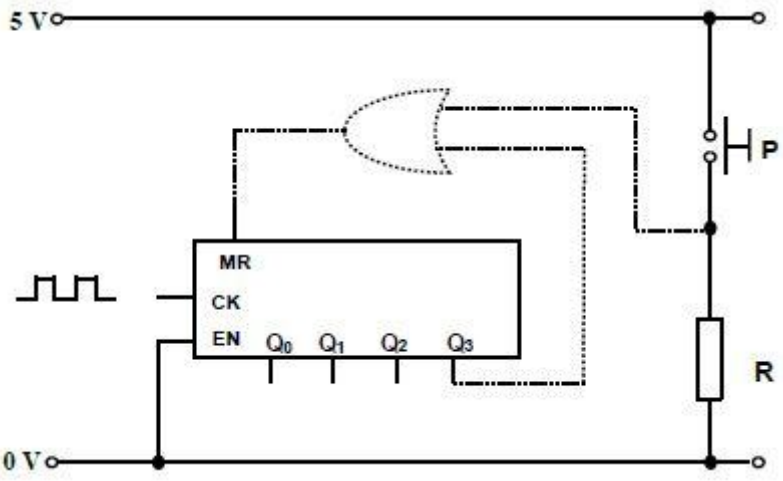
Pathway – Space wave

i. Due to high frequency, microwaves do not diffract around terrestrial objects, so line of sight required.
ii. Microwaves travel straight through atmosphere and ionosphere.
iii. Significant attenuation of transmission by atmosphere and ionosphere.
iv. Different frequencies used for up-link and down-link so that satellite receiver is not desensitized.
v. Up-link normally at higher frequency (17 – 18 GHz) than down-link (10 – 13 GHz) since higher frequency gives narrower beam and can be given more power to overcome attenuation. (Converse argument for down-link based on wider target area and low power available from satellite).
vi. Microwave communication allows for greater bandwidth to carry complex information.

[6]

Q3.

(a)



Correct logic gate to MR ✔
Q_3 to logic gate input ✔
Midpoint of switch chain to logic gate input ✔

OR

Accept 2 diodes in correct position ✔✔ Correct orientation ✔

2 marks only for both resets in correct positions but no logic gate.

1 mark only for any correct single reset circuit.

3

(b) **(A . C)** ✔ + **(B .** $\overline{C}$**)** ✔

Second mark includes the (+)

Also allow commutative equivalents such as ***(B.*** $\overline{C}$***) + (A.C)***

2

(c)

Decimal number	C	B	A	D	E	F	W
0	0	0	0	1	0	0	0
1	0	0	1	1	0	0	0
2	0	1	0	1	0	1	1
3	0	1	1	1	0	1	1
4	1	0	0	0	0	0	0
5	1	0	1	0	1	0	1
6	1	1	0	0	0	0	0
7	1	1	1	0	1	0	1

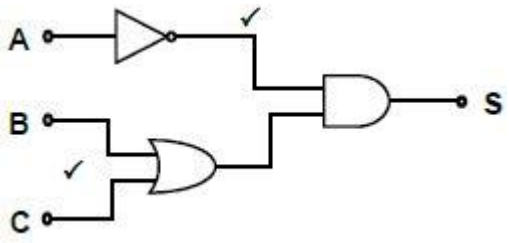
1

(d) numbers 2, 4 and 6 ✔

accept even numbers

1

(e)



NOT A into the AND gate ✔

(B OR C) into the AND gate ✔

Only 1 mark if AND gate is incorrect

Do not accept use of NAND, NOR, EXOR / EXNOR gates to generate equivalent functions.

2

[9]