Mark Scheme 2825/05
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TELECOMMUNICATIONS

Question 1	Expected Answers	Marks

(a)

(i) Frequency of signal generator

One cycle of waveform lasts 30 ms 1

frequency = 1 / period

= 1 / 0.030 = 33 Hz 1

(ii) Frequency of sampling

Each sample lasts for a time of 2.5 ms 1

frequency = 1 / 0.0025 = 400 Hz 1

(iii) Number of wires

Number of voltage levels = 12 1

Number of bits converted = 2 1

Number of bits converted = 4 1

(Allow answer of 5 if zero volt common line is included)

(b)

(i) Increasing ADC sampling:The trace would look almost identical to Fig.1.2 1

because there are only 16 possible levels, no matter how fast the sampling 1

(ii) Increasing the number of bits: Trace would still look almost identical to Fig.1.2

because no matter how many possible levels, they only occur every 2.5 ms 1

(c)

(i) Long distance multicore cable would be expensive

Cross-talk would occur between parallel lines

Long distance transmission of parallel word results in skew (bits don't arrive at same time) (any two) 1 1

(do not award any comment on multipath dispersion as this applies to parallel and serial)

(ii) The n-bit parallel word from the ADC is input to a Parallel-to-Serial shift register circuit 1

which outputs each bit into the single line one after the other 1

At the other end of the line a Serial-to-Parallel shift register circuit reassembles the output. 1

Question 2	Expected Answers	Marks

(a)

(i) Difference amplifier The output at C depends on the difference between B and A 1

$V_C = (V_B - V_A) \times$ open-loop gain 1

(ii) -ve saturation (allow from -13V to -15V) 1 0 V 1
+ 2V (ignore sign) 1

(b) Voltage at A = 15 x 12 / (18 + 12) 1

= 6 V 1

(c) (i) Thermistor correctly circled 1

(ii) As the temperature of the thermistor increases / decreases

the resistance of the thermistor decreases / increases

①

(iii) If B = 6V , the current in 5 kW resistor = 6 / 5 = 1.2 mA 1

Resistance of thermistor = V / I = (15 - 6) /1.2 1

= 7.5 kW 1

(d) The motor current is only P / V ≈ 150 / 15 = 10 mA

The op-amp is not capable of delivering a large current to a powerful motor

The op-amp output is limited by saturation

The op-amp has too large an output resistance (any two points) 1 1

(e) Without the diode the motor would run all the time 1

(ie function of diode or wtte)

Because both +ve and -ve saturations will drive motor 1
(ie effect of function of diode)

(f) When it is cold, the resistance of the thermistor is greater than 7.5 kW

so the voltage at point B is less than 6V and op-amp is in -ve saturation - motor off

When it is hot, the resistance of the thermistor is less than 7.5 kW

So the voltage at B is greater than 6V and op-amp is in +ve saturation - fan turns.

(any three points) 1 1 1

Question 3	Expected Answers	Marks

(a) AM AM = Amplitude Modulation 1

The amplitude of a high frequency carrier wave

is controlled by the (instantaneous) value of information signal 1

FM FM = Frequency Modulation 1

The frequency of a high frequency carrier wave

is controlled by the (instantaneous) value of information signal 1

(b) FM is constant amplitude signal so no information is contained in amplitude

Noise accumulates on FM amplitude and so can be removed

However, in AM the amplitude variation is the information

Thus noise is integral part of AM signal (or wtte)

(up to 2 marks for comments on *noise*) 1 1

FM broadcasts an audio bandwidth up to 15 kHz

AM broadcasts are limited to a maximum audio bandwidth of about 4 kHz.

Broadcast FM has a greater dynamic range than FM

(up to 2 marks for *other reasons*) 1 1

(c) Nationwide coverage of AM on LF would require only one transmitter 1

located in middle of country / population

because LF propagates by surface wave over 1000 km. 1

Nationwide coverage of FM on VHF would require many transmitters 1

located all over country with different carrier frequencies

because VHF propagates by space wave only to a range of about 40 km. 1

(d) Diagram of Dipole aerial 1 Typical VHF carrier f = 100 MHz 1

(between 30MHz and 300MHz)

Wavelength $\lambda = c / f$

$= 3 \times 10^8 / 100 \times 10^6$

$= 3$ m 1

Dipole length $= \lambda / 2 = 1.5$ m 1

Question 4	Expected Answers	Marks

(a) Noise — Any unwanted energy / power added to signal — 1

(b) Signal power decreases along transmission path ie attenuation occurs — 1

① Noise power remains more or less constant - hence ratio decreases

(c)

(i) Signal-to-noise = 34 = 10 lg P_{sig} / 0.28 x 10^{-6} — 1

Thus P_{sig} = $10^{3.4}$ x 0.28 x 10^{-6} — 1

= 0.70 mW

(ii) Attenuation along fibre = 10 lg 0.70 x 10^{-3} / 22 x 10^{-3} — 1

= 15 dB — 1

(iii) Separation of exchanges = 5 (sections) x 15 / 0.30 1

= 250 km 1

(d) Speed of light in core = 3×10^8 / 1.5 = 2×10^8 1

Minimum time in fibre = 250×10^3 / 2×10^8 1

= 1.25 ms 1

Question 5	Expected Answers	Marks

Mobile Telephone Network

System uses carrier frequencies in the UHF region / GHz region

This means using small wavelengths in the order of cms

This means small and inconspicuous aerials can be used to transmit and receive

Waves in the UHF region travel by line-of-sight so have limited terrestrial range

Low power transmitters mean the same frequencies can be used as carriers over and over again

Up to 3 points

Country is divided into cells

Each cell is normally in the order of a few km radius

At the centre of each cell is a base station

Several base stations from a cluster of cells are connected to a cellular exchange

The cellular exchange is connected to the Public Switched Telephone Network (PSTN)

Up to 3 points

When mobile phone is activated it transmits an identifying digital signal

This signal is picked up by a number of base stations under the control of cellular exchange

Cellular exchange selects appropriate base station through which to link mobile to PSTN

Up to 2 points