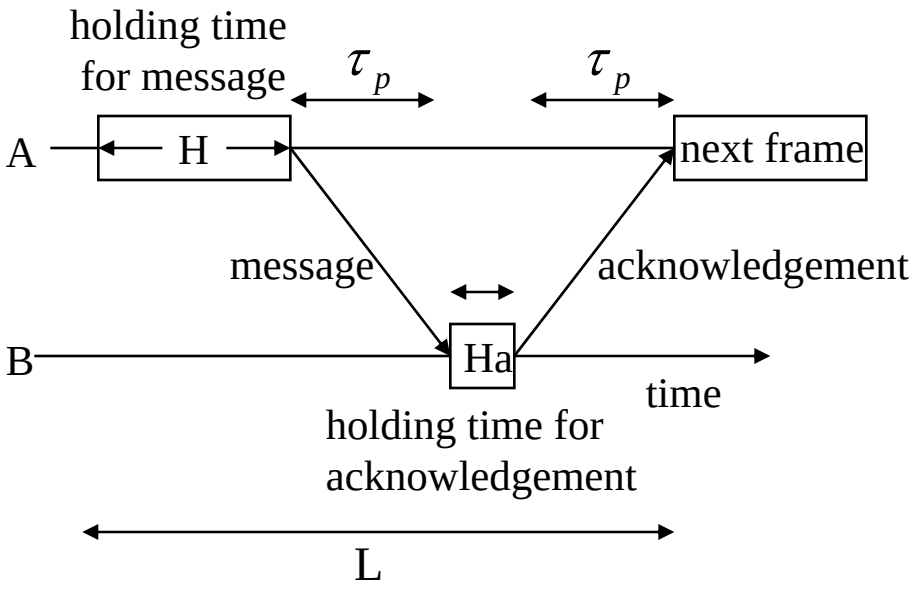
EE4004 Telecommunications Summer 2009

Question 1(a)

Data flow between two computers using a stop and wait ARQ scheme.



$$U \approx \frac{H}{H + 2\tau_p} = \frac{1}{1 + \frac{2\tau_p}{H}} = \frac{1}{1 + 2a}$$

If the bit error probability is p, then the probability that a frame will be correct is (1-p)^n where n is the number of bits in the frame. Thus, on average a frame will have to be sent M = 1/ (1-p)^n times to guarantee a successful transmission.

$$U = \frac{H}{M\,(H + 2\tau_p)} = \frac{(1-p)^n}{1 + \frac{2\tau_p}{H}} = \frac{(1-p)^n}{1 + 2a}$$

10 marks

Question 1(b)

$$U = \frac{(1-p)^n}{1+\frac{2\tau_p}{H}}$$

Expressing the holding time as a function of the frame length and the line data rate R gives:

$$U = \frac{(1-p)^n}{1+\frac{2\tau_p R}{n}}$$

To obtain the maximum utilization, U has to be differentiated w.r.t. n.

Note:

$$y = \frac{u}{v} \Rightarrow \frac{dy}{dx} = \frac{vdu - udv}{v^2}$$

$$y = (1-p)^x \Rightarrow \frac{dy}{dx} = (1-p)^x \ln(1-p)$$

Therefore:

$$\frac{dU}{dn} = \frac{\left(1+\frac{2\tau_p R}{n}\right)(1-p)^n \ln(1-p) - (1-p)^n\left(-\frac{2\tau_p R}{n^2}\right)}{\left(1+\frac{2\tau_p R}{n}\right)^2}$$

At maximum:

$$\frac{dU}{dn} = 0 \Rightarrow \left(1+\frac{2\tau_p R}{n}\right)\ln(1-p) + \frac{2\tau_p R}{n^2} = 0$$

$$\Rightarrow \ln(1-p)n^2 + 2\tau_p R \ln(1-p)n + 2\tau_p R = 0$$

$$\Rightarrow n = \frac{-2\tau_p R \ln(1-p) \pm \sqrt{\left(2\tau_p R \ln(1-p)\right)^2 - 4\ln(1-p)2\tau_p R}}{2\ln(1-p)}$$

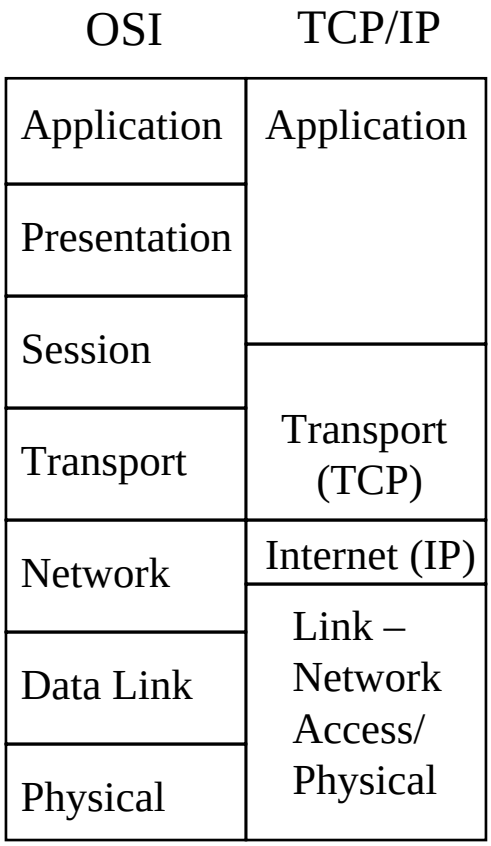
8 marks

(c) R = 15kbps, τ_P=15ms, p=0.002

Putting these into the formula above and taking the positive value gives n = 300.

2 marks

Question 2(a)



Application: Frequently needed communications services such as file transfer, terminal emulation, remote login etc.
Presentation: Translation between different system data formats e.g. ASCII/EBCDIC, UNIX/DOS.
Session: Set-up, maintaining and closing down of communication session.
Ensures consistency of information at each end of the network e.g.
for electronic fund transfer.
Transport: Makes data flow transparent to the network e.g. to get packets
back in sequence after being sent as datagrams.
TCP: Transport Control Protocol.
Network: Looks after routing of data through the network.
IP: Internet Protocol
Data Link: Protocols for point-to-point data transfer and error detection
e.g. HDLC.
Physical: The electrical and mechanical properties of the interface.

9 marks

Question 2(b)

(i) IP addressing

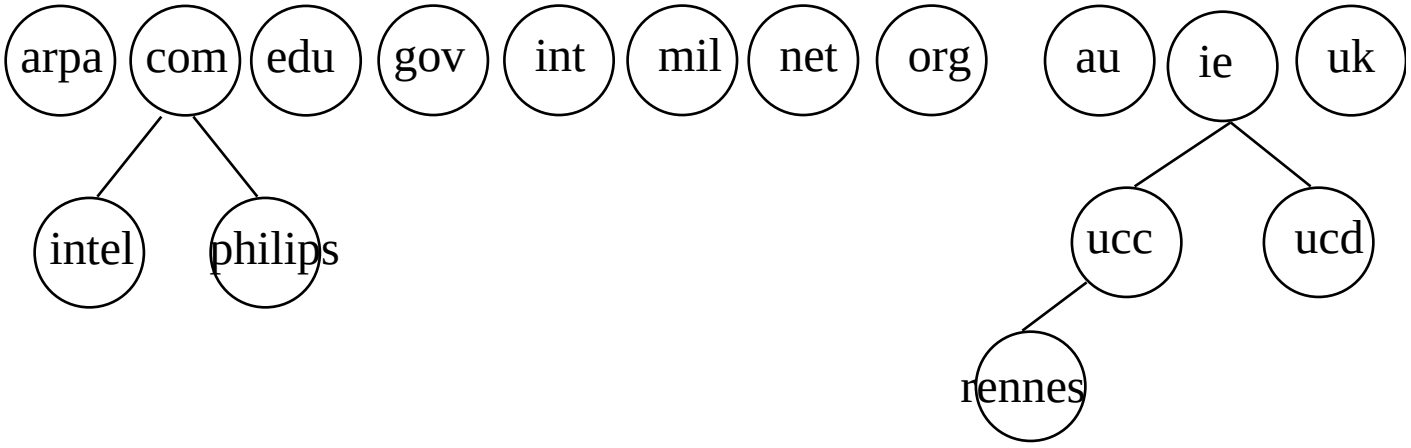
An IP address is used for routing - this consists of a netid and a hostid. The netid is allocated by the Internet Network Information Centre. The hostid which is the address of the host on the network is determined by the system administrator. The IP address consists of 4 bytes which is usually written in “dotted decimal” notation e.g.
the IP address 10000000.01000000.00100000.00010000 is written 128.64.32.16

There are different classes of IP addresses to allow networks to be set up which have widely different numbers of hosts.

4 marks

(ii) The domain name system

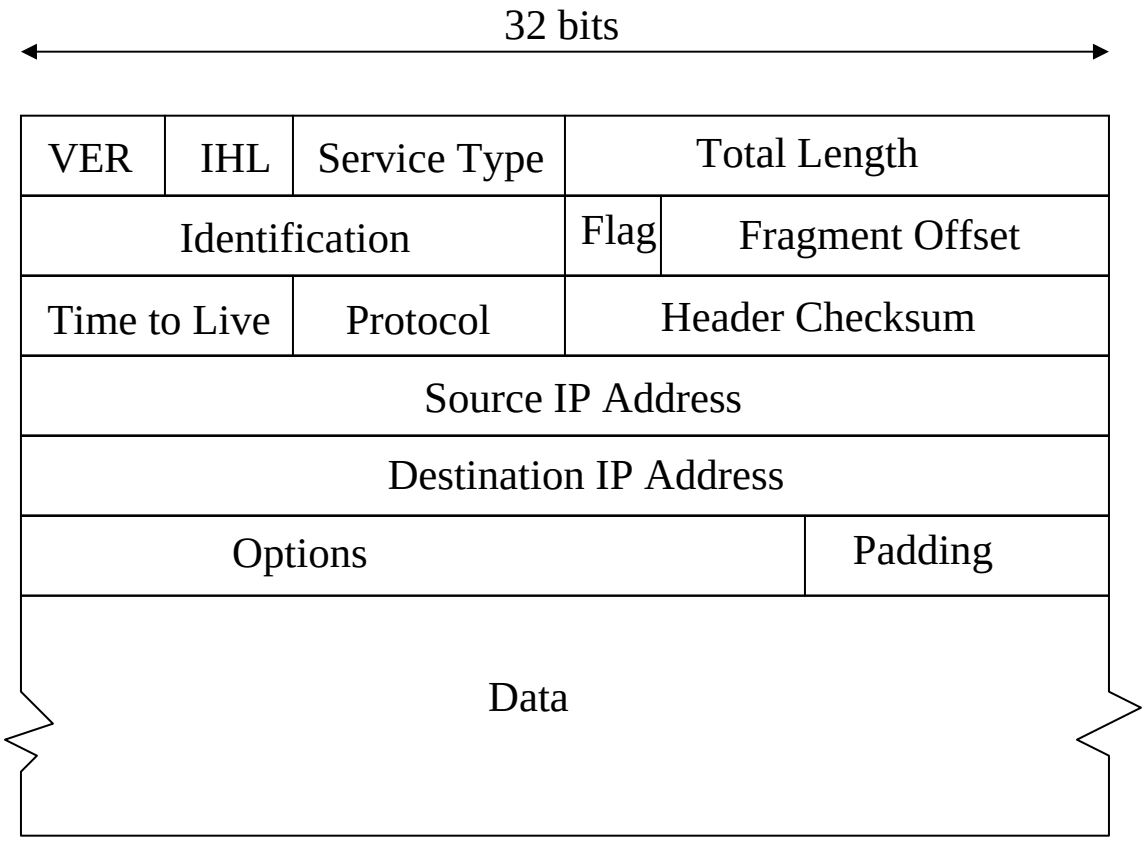
An alternative form of Internet address is a hostname e.g. rennes.ucc.ie Hostnames are part of a Domain Name System (DNS) which is a distributed database that enables an IP address to be found from a hostname address and vice versa using a resolver. DNS is based on a tree structure which has the country names (two letters), and several generic domains at its top level e.g.



3 marks

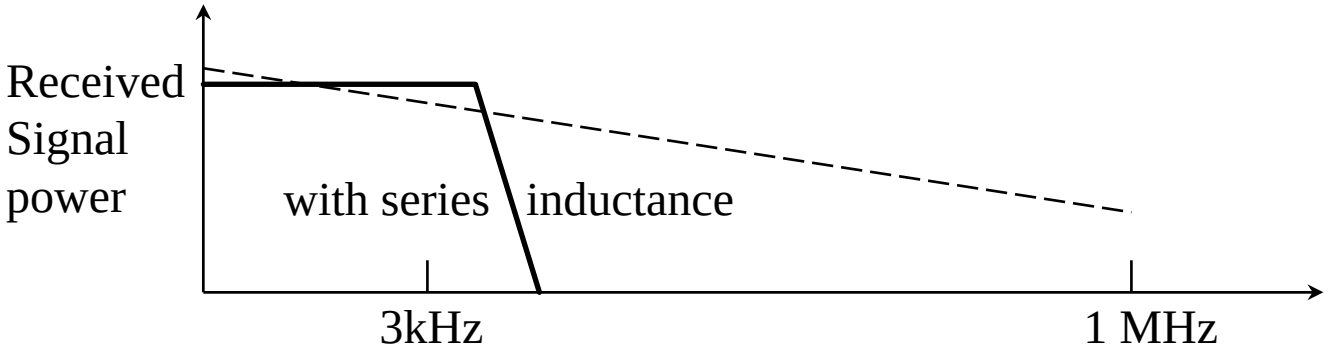
2(b) (iii) The format of an IP packet

The IP data packet has a header of at least 20 bytes followed by optional extra header information and then the data.

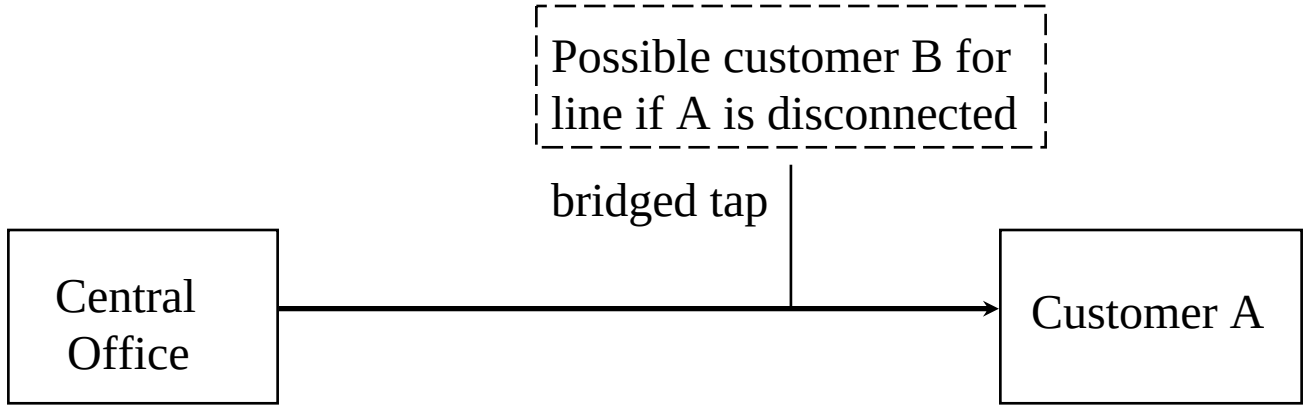


4 marks

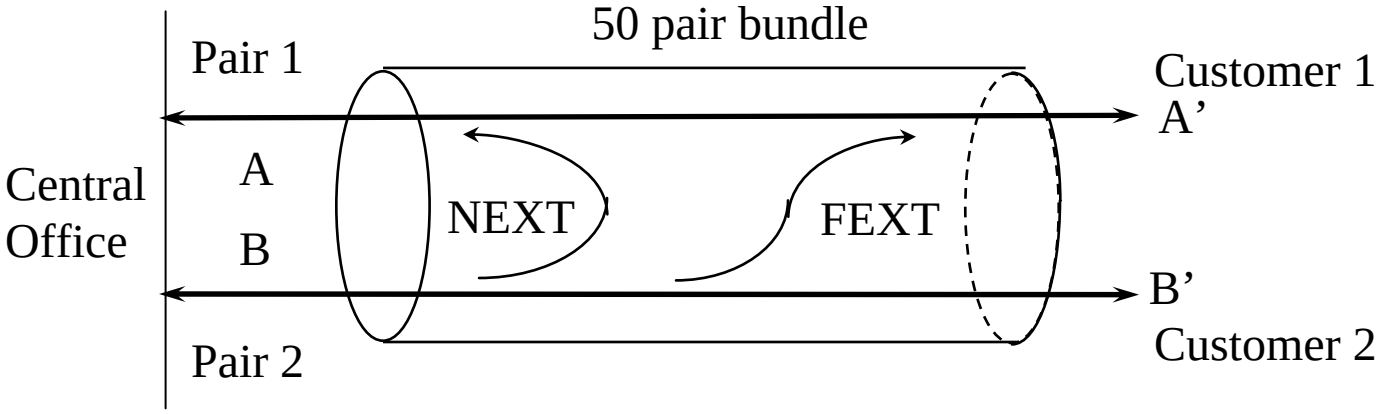
Question 3 (a) The main signal degradation mechanisms in DSL.



Attenuation, especially for lines with series inductors.



Signal reflections and echoes caused by bad wiring layout.

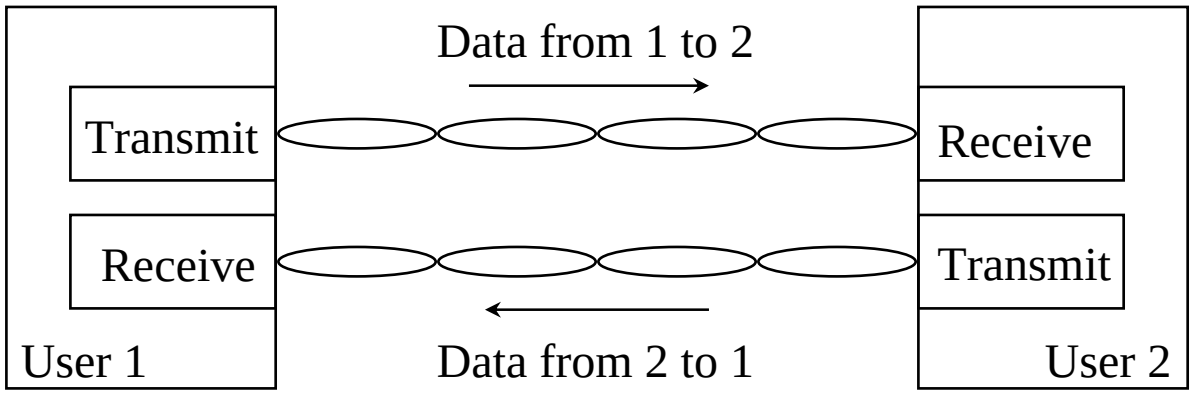


Near end and far end cross-talk – NEXT and FEXT.

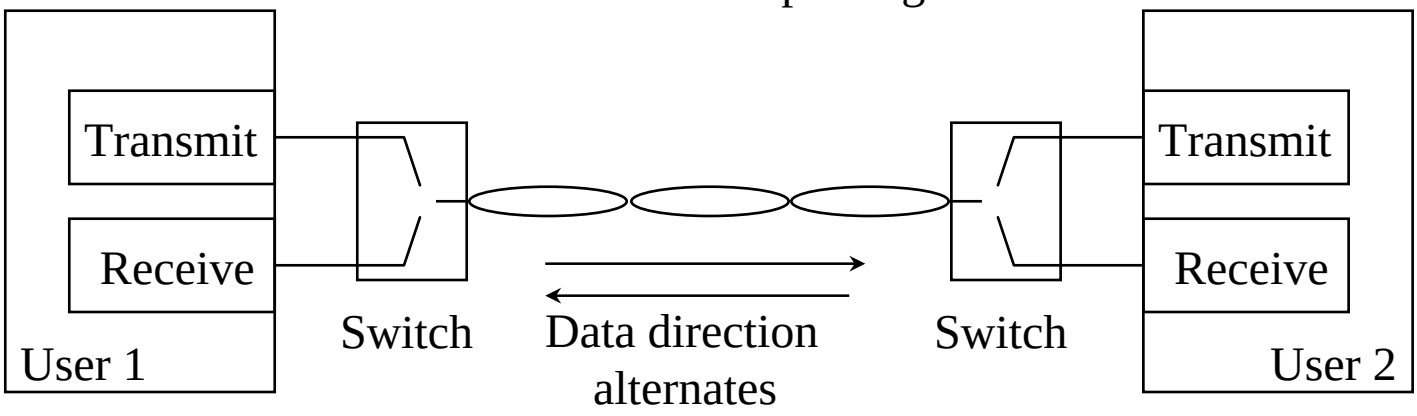
5 marks

(b) The 4 commonly used transmission duplexing methods in DSL.

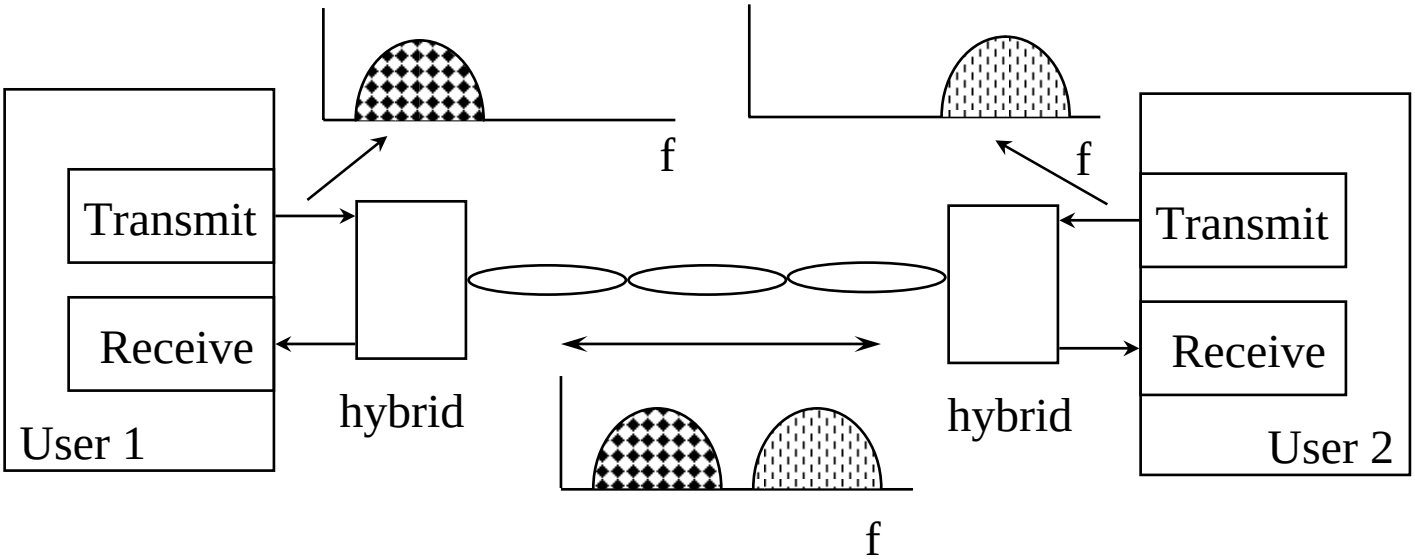
Four-Wire Duplexing



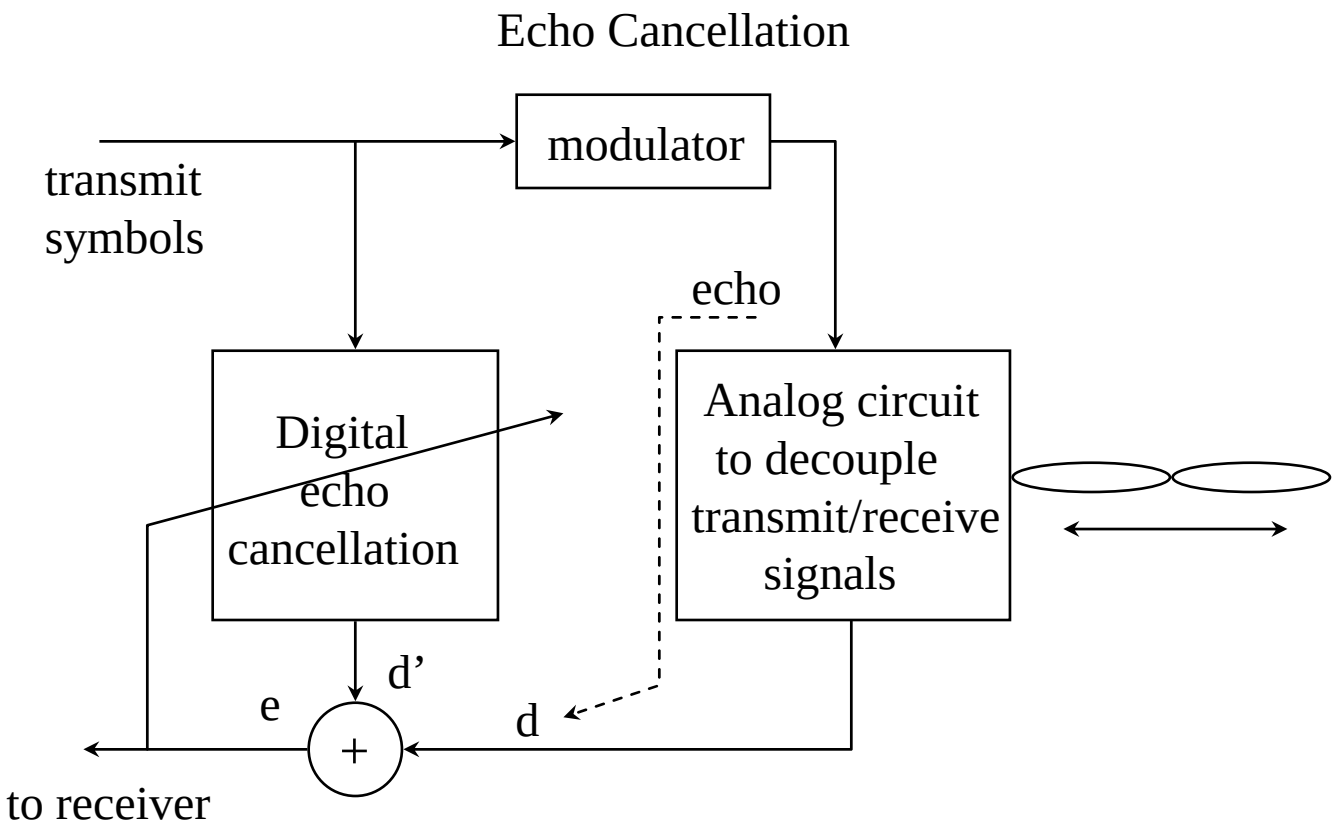
Time Division Duplexing



Frequency Division Multiplexing



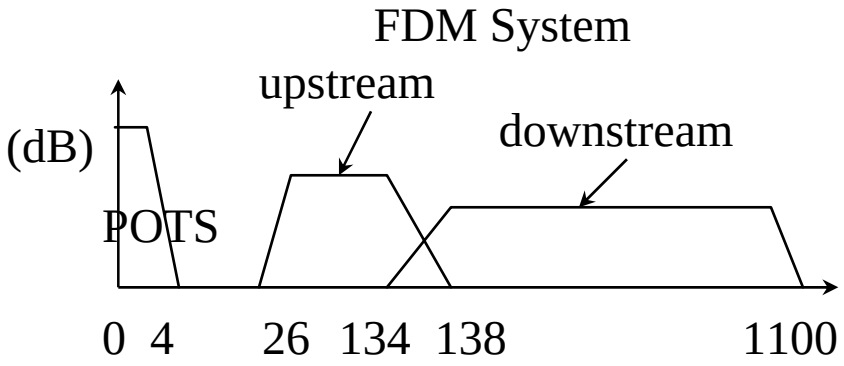
3(b) continued

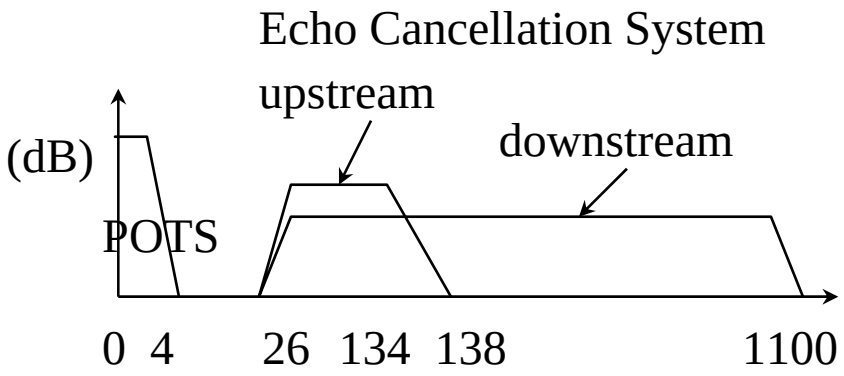


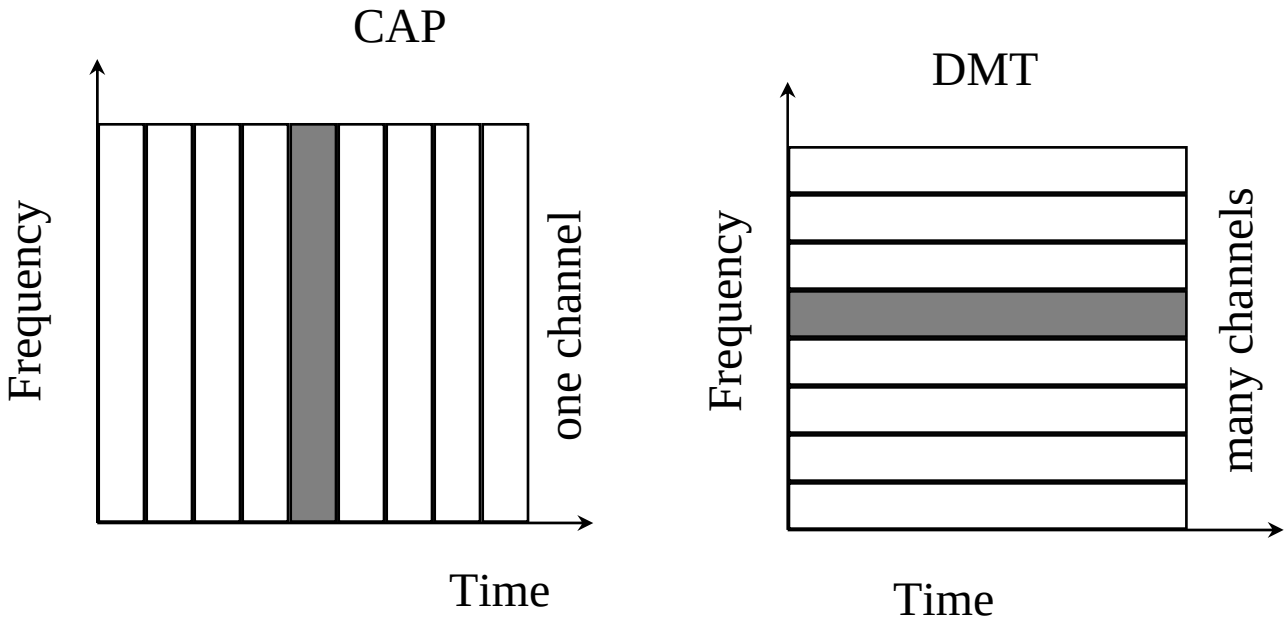
6 marks

Question 3(c)

Allocation of frequencies in the ADSL system:







Each symbol in CAP lasts a short time(~1us) but occupies the full line bandwidth. Each symbol in DMT lasts a long time (250us) but only occupies a small portion of the line bandwidth. High data rates are obtained by having many channels in parallel.

9 marks