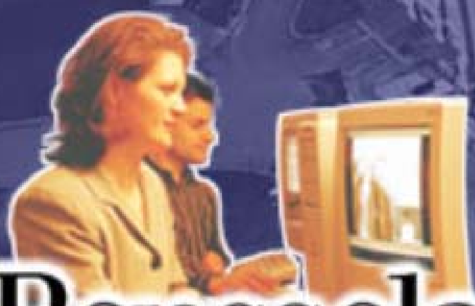
ECSE-6660: Broadband Networks

Homework 4

Please Submit Online in the WebCT dropbox

Deadline : 10th April (non-tape-delayed)

April 17th (tape-delayed)



Reading Assignment & Quick Questions

Reading assignments count for a substantial part of homework credit

Carefully review slide sets 10,11,12; Read Chapter 2 of S. Keshav's book, and Chap 1,2,3 of Ramaswami/Sivarajan's book.

Then answer the following quick true/false questions that test your knowledge. Please submit the electronic version of this powerpoint file with your answers. (Cut-and-paste the tick (√) over the appropriate boxes on the left)

[91 questions; 10/9 points per question (upto 1 mistake ignored)]

T F

- ☐ ☐ Data traffic overtook phone traffic in 1999, implying that data revenues overtook phone revenues at the same time
- ☐ ☐ PBX replacement is a major IP telephony potential market
- ☐ ☐ Waveform coders use a voice-tract model and send across just the parameters of this model
- ☐ ☐ ADPCM is an example of a vocoder
- ☐ ☐ Cell phones use a hybrid of waveform and vocoding techniques to have a balance between low bit rate and high perceived voice quality
- ☐ ☐ The difference between PAM and PCM is the use of quantization in the PAM scheme

- ☐ ☐ Quantization refers to the discrete sampling of a continuous signal at a rate greater than twice its highest frequency component
- ☐ ☐ The idea behind companding is that lower amplitude samples need to be quantized more finely than higher amplitude samples
- ☐ ☐ Differential PCM and delta modulation use the fact that successive voice samples are largely un-correlated
- ☐ ☐ Unvoiced sounds involve the use of the human voice box
- ☐ ☐ In adaptive-predictive-coding, the prediction coefficients are also adapted
- ☐ ☐ Subband coding involves a time-domain decomposition followed by separate coding of different time-slots (also called "bands")
- ☐ ☐ G.722 is a high-fidelity coder, I.e. it uses a 7kHz bandwidth for voice, even though basic voice needs only 4 kHz
- ☐ ☐ The human ear requires an exact time-domain replica of the spoken speech to interpret it correctly and perceive it as "high-quality"
- ☐ ☐ The CELP coder is an example of a hybrid-coder that uses both waveform and vocoder techniques
- ☐ ☐ SIP allows you to call email addresses
- ☐ ☐ SIP can be used for remote "presence" applications (eg: monitoring home applicances and security remotely)
- ☐ ☐ SIP is a control-plane protocol where as RTP is a data-plane protocol
- ☐ ☐ SIP also reserves bandwidth on the path in addition to setting up the end-to-end phone call

- ☐ ☐ SIP is a lightweight control-plane protocol for IP telephony compared to H.323
- ☐ ☐ SDP is a protocol used to describe IP telephony call parameters
- ☐ ☐ SIP uses a client-server approach to provide one level of name resolution, and also uses DNS to finally locate the IP address to which a call needs to be forwarded
- ☐ ☐ SIP uses a gateway to interconnect the PSTN network with the IP-based telephony system
- ☐ ☐ Voice services such as voice-mail, three-way calling and call forwarding can be fully implemented using SIP.
- ☐ ☐ An MLM laser produces multiple modes on multimode fiber whereas a SLM laser just produces one mode on such fibers
- ☐ ☐ 1.3 um band has superior attenuation characteristics compared to 1.5 um band
- ☐ ☐ 1.3 um band (standard single mode fiber) has superior chromatic dispersion characteristics compared to 1.5 um band
- ☐ ☐ Diffraction is a phenomenon which can occur independent of matter, I.e. it is a light-light interaction phenomenon
- ☐ ☐ Light energy is present both in the longitudinal and transverse modes
- ☐ ☐ In a waveguide, light frequency remains constant, but its speed and wavelength reduce (compared to vacuum)
- ☐ ☐ Ray optics is best used when examining light phenomena involving sizes smaller than the light ray's wavelength
- ☐ ☐ In ray-optics, light travels on the path that takes the least time
- ☐ ☐ Light travels in fiber using the phenomenon of total-internal-reflection
- ☐ ☐ The refractive index of the core of fiber differs significantly from that of the cladding
- ☐ ☐ Ray optics can predict a finite number of modes that propagate in the fiber

- ☐ ☐ Microbends are used to intentionally kill some modes and reduce modal dispersion
- ☐ ☐ Modal dispersion and chromatic dispersion share the characteristic that they cause inter-symbol interference (and hence a strong upper bound on bit rate)
- ☐ ☐ Diffraction with polychromatic light will lead to the separation of component wavelengths
- ☐ ☐ When multiple waves interference, it leads to distinct maxima and minima (like sinc-squared functions)
- ☐ ☐ Both absorption and scattering lead to attenuation, and can be combated by raising signal power or operating at the bands where these phenomena have a minimum effect
- ☐ ☐ Rayleigh scattering is more pronounced in the visible spectrum, than in the IR spectrum
- ☐ ☐ The small attenuation peak in the 1400nm band is because of OH absorption (and was recently gotten rid of in the Lucent AllWave fiber)
- ☐ ☐ The C-band is the conventional 1550 nm band where most of the long-distance optical equipment operate in.
- ☐ ☐ EDFAs provide amplification in both the 1.3um and 1.55um bands
- ☐ ☐ Raman amplification uses a non-linear phenomenon called SRS.
- ☐ ☐ Multimode fibers have core diameters of 8-10 um
- ☐ ☐ Single mode means that exactly one wavelength passes through the fiber
- ☐ ☐ The single mode energy is present in both the core and cladding (latter known as evanescent wave)
- ☐ ☐ The final end-result (pulse broadening) caused by modal dispersion is fundamentally different from the end-result caused by chromatic dispersion (ignoring magnitude of effects)
- ☐ ☐ Modes (other than the fundamental mode) satisfy boundary conditions (for maxwell’s equation) at the points where they undergo total internal reflection

- ☐ ☐ Graded index fiber is used to reduce the delay spread in multimode propagation
- ☐ ☐ Though graded index fiber and dispersion shifted fiber have different objectives, they are engineered by managing the refractive index profile of the fiber core, relative to the cladding
- ☐ ☐ Chromatic dispersion occurs because different spectral components of the pulse travel at different velocities (because refractive index is a function of λ)
- ☐ ☐ Dispersion-shifted fiber (DSF) is created by reducing the material dispersion component of chromatic dispersion in the fiber
- ☐ ☐ In DSF fiber, the zero-dispersion point is shifted (from the 1.3 um band) to 1550nm
- ☐ ☐ Anomalous chromatic dispersion occurs in the 1.3 um band
- ☐ ☐ Anomalous chromatic dispersion, combined with negative chirping (effect of lasers) leads to additional pulse broadening
- ☐ ☐ Chromatic dispersion is a significant issue for 1 Gbps, 100 km fiber lengths
- ☐ ☐ In-fiber chirped bragg gratings are used to compensate for chromatic dispersion by adding extra phase for selected wavelength bands
- ☐ ☐ Linear polarization refers to the fact that the polarization vector does not change its direction over time.
- ☐ ☐ Circular polarization leads to helical field pattern because the light energy is also in motion
- ☐ ☐ Fiber is made out of a birefringent material
- ☐ ☐ A birefringent crystal resolves the incident light into two rays that have orthogonal polarizations
- ☐ ☐ Polarization mode dispersion is a significant issue for medium-haul OC-48 transmission
- ☐ ☐ Stokes wave is the wave from which power is lost in SRS and SBS
- ☐ ☐ SRS is attractive for amplification because it is a broadband effect (occurs over 15 Thz)

- ☐ ☐ A photon of higher wavelength also has higher energy
- ☐ ☐ Phonon refers to mechanical or lattice vibrational energy
- ☐ ☐ The Kerr effect is attractive for modulation because a relatively small change in the applied electric field is magnified into a larger-than-linear change in refractive index
- ☐ ☐ Self-phase modulation occurs because the refractive index varies with higher intensities leading to a positive chirp in gaussian pulses
- ☐ ☐ Four-wave mixing is a phenomenon that occurs with tight WDM channel spacing, high bit rates and high powers leading to irreducable in-band crosstalk
- ☐ ☐ Non-zero DSF (NZ-DSF) fibers have a small amount of positive chromatic dispersion to combat the nonlinear effects of FWM
- ☐ ☐ Submarine fibers use negative dispersion fibers to combat modulation instability
- ☐ ☐ In the soliton regime, the non-linear self-phase modulation effects exactly cancel out the chromatic dispersion effects
- ☐ ☐ Hollow nanotube fibers are attractive waveguides because vacuum has a much larger transmission window, minimal attenuation and no undesirable light-matter interactions
- ☐ ☐ Optical taps have a coupling ratio of 1/2
- ☐ ☐ A 3-dB coupler equally splits the optical energy, I.e. broadcasts the signal, to its outputs
- ☐ ☐ In a star coupler, all outputs see all inputs; but collisions are avoided because the information is separated into different wavebands
- ☐ ☐ In a circulator, the signal circulates (I.e. reflects) back to the source
- ☐ ☐ Circulators are used in OADMs along with Bragg filters
- ☐ ☐ A Bragg Cavity is an example of a blazed diffraction grating
- ☐ ☐ Apodized bragg gratings cuts side lobes (reflectance profile), but increases main lobe width
- ☐ ☐ Fabry-perot filters result in phase-shifted copies of waves adding together

- ☐ ☐ A thin-film multilayer filter is similar to having three fabry-perot cavities, and the reason it cuts sidelobes is because the rays that pass through will have to satisfy the FP conditions for each cavity
- ☐ ☐ Mach-Zehnder interferometer involves splitting the power of the wave, and combining it later after possibly adding a phase lag
- ☐ ☐ An arrayed-waveguide grating can be thought of as a generalization of a Mach-Zehnder interferometer
- ☐ ☐ A Mach-Zehnder interferometer is also called an "etalon"
- ☐ ☐ An acousto-optic filter effectively creates (one or more) bragg gratings by the interaction of an acoustic wave with the waveguide
- ☐ ☐ OEO Regenerators are less preferred than EDFAs because they are dependent upon the bit rate, modulation format etc and not easily upgradable
- ☐ ☐ An EDFA can be used to amplify the entire C- and S-bands
- ☐ ☐ Dynamic wavelength crossconnects can be created using arrayed waveguide gratings