1. Static networks: packet switching in the optical layer.

   a) The simplest possible MAC protocol is *random access* (ALOHA). In the slotted version (slotted ALOHA), based on a slot-synchronized, single-channel shared broadcast medium, any station having a packet to transmit sends it in the next available slot. Assume that there are N independent stations and each station transmits into each slot with probability p. Determine the probability $p_s(N)$ that a transmission is succesful. Let then $N \to \infty$ and $p \to 0$ in such a way that $Np \to \rho$ (where ρ refers to the offered load in packets per slot). Determine the throughput $\theta = \rho p_s(\infty)$ in this limiting case and find its maximum as a function of ρ.

   b) A bit more advanced MAC protocol is called *tell-and-go*. Now each station with a packet to transmit first communicates to all receivers the destination of the packet, and then sends the packet in the next time slot. All the collisions can be avoided using TDM-T/WDMA in FT-TR mode. Although conflicts cannot be avoided, the receiver can always choose one of the conflicting packets. Assume again that there are N independent stations and each station transmits into each slot with probability p (uniformly to the other stations). Determine the probability $p_t(N)$ that at least one station is transmitting to receiver j in a timeslot. Let then $N \to \infty$ (keeping, however, p constant). Determine the throughput per receiver, $\theta = p_t(\infty)$, in this limiting case and find its maximum as a function of the offered load per receiver, $\rho = p$.

2. Wavelength Routing Networks.

   a) Consider the bidirectional ring WRN consisting of 7 WSXC's and 7 non-blocking NAS's depicted in slide 39 of lecture 9. Solve the routing and channel assignment problem that realizes the full logical/optical connectivity between the 7 stations using 6 wavelengths.

   b) Consider the multistar WRN consisting of 7 WSXC's and 7 non-blocking NAS's depicted in slide 39 of lecture 9. Solve the routing and channel assignment problem that realizes the full logical/optical connectivity between the 7 stations using only 2 wavelengths.

3. Linear Lightwave Networks.

   a) Consider the mesh LLN consisting of 5 waveband selective LDC's and 7 non-blocking NAS's depicted in slide 39 of lecture 9. Solve the routing and channel assignment problem that realizes the logical connection hypergraph depicted in slide 42 of lecture 9 using 2 wavebands, 3 wavelengths per waveband, and TDM/T-WDMA in FT-TR mode.

   b) Consider the multistar LLN consisting of 7 waveband selective LDC's and 7 non-blocking NAS's depicted in slide 39 of lecture 9. Solve the routing and channel assignment problem that realizes the logical connection hypergraph depicted in slide 42 of lecture 9 using only 1 waveband, 3 wavelengths per waveband, and TDM/T-WDMA in FT-TR mode.