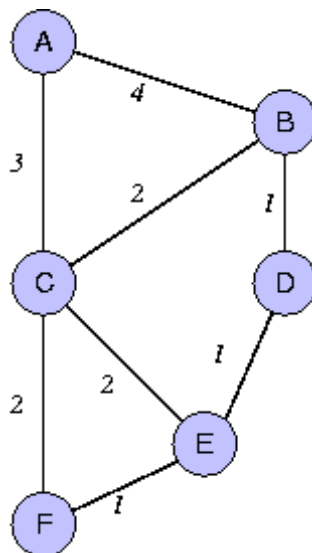


1. Brief questions (please answer with max. 50 words per item, 1 pt per item, total 10 pt).
  - a. Why are the RTCP interval timers randomized?
  - b. We have seen leaky buckets in a variety of applications. Name three actions that a leaky bucket can take. Where would each of these actions be appropriate?
  - c. Assume the MPEG frame sequence IBBPBBIBBP[B]BIBBPBB... If the frame enclosed in [] is lost, what other frames are affected? (Mark the affected frames in the sequence).
  - d. Why can DVRMP not just use the regular routing tables in making forwarding decisions?
  - e. "Normal conversation is about 60 dB." What does this mean? How much louder (as a multiple) than the softest audible sound is this?
  - f. Why would UDP be advantageous as a means for carrying signaling messages (as opposed to TCP)?
  - g. Name two advantages and two disadvantages of proxying (vs. redirecting) SIP requests.
  - h. How do you label a queue that has Poisson arrivals, fixed (deterministic) service times, one server and an infinite buffer?
  - i. Describe the role of the PATH message in RSVP.
  - j. Reverse path forwarding: Consider the topology and link costs below and suppose that node E is the multicast source. Using arrows to indicate flows, with "-->" indicating a packet that is not forwarded beyond the receiving router, indicate links over which packets will be forwarded using RPF, and links over which packets will not be forwarded, given that node E is the source.



2. *Essay:* What are the advantages and disadvantages of RSVP being receiver-oriented? (Also describe briefly what it means.) What parts of RSVP could one remove if multicast was not important? Describe a simplified version of RSVP without multicast support, but that would be backwards-compatible. (10 pt)

3. *Design task:* Design a voicemail system for an Internet telephony service provider. Justify your protocol choices and show what kind of servers are needed. The voicemail service needs to play announcements to users, allow users to retrieve their voicemail via phone and web page and deliver an instant messages whenever they receive a new phone call. How much storage space would you need if each user receives ten calls a day, lasting two minutes each? Users are allowed to keep their messages for one week. (10 pt)