

Tutorial No 5, Semester 2, 2025/2026

1. The first 11 notes of a well-known Singapore National Day song are: D4, D5, B4, C5, D5, A4, B4, A4, B4, C5 and A4. What are the MIDI key numbers for these 11 notes? Give the paper roll track numbers for the first 11 notes of this song which is to be played by a player piano using a standard player piano paper roll. How can the MIDI key numbers be converted to paper roll track numbers in general? If we start on C4 instead of D4, give the MIDI key numbers and the paper roll track numbers for these 11 notes, assuming that the notes of the song will still have the same interval relationships from the first note.
2. A desktop computer is able to send and receive MIDI messages through MIDI in and MIDI out sockets through an interface box connected to the computer, and the sockets of the box are labelled IX and OX respectively. An electronic organ which has only MIDI in and MIDI out sockets labelled IR and OR respectively sends MIDI messages to the computer to enable a song to be composed on the computer. An electronic synthesiser has MIDI in, MIDI out and MIDI thru sockets labelled IS, OS and TS respectively, an electronic tone generator has MIDI in, MIDI out and MIDI thru sockets labelled IG, OG and TG respectively, and an electronic piano has

MIDI in, MIDI out and MIDI thru sockets labelled IP, OP and TP respectively. The completed song is to be performed on the four electronic musical instruments (including the electronic piano). Give the connections which need to be made between the computer and the four electronic musical instruments (including the electronic organ) to enable the song to be composed and then performed as desired. If the electronic organ does have a MIDI thru socket, how would this affect the required connections?

3. The first 11 notes of the National Day song in question 1 are sent to an electronic synthesiser by a series of MIDI messages. The song is to be played on the trumpet MIDI instrument in the lowest MIDI channel by turning the notes on and off as fast as possible starting from the note D4. What are the MIDI messages which should be sent?
4. 15 electronic keyboards are connected by MIDI cables to a notebook computer to enable all the keyboards to play a piece of music together. One particular chord in this piece is to be played simultaneously by all the 15 electronic keyboards, with all the 15 keyboards playing the same number of notes of this chord. If all the notes of the chord have to be played within 0.08 seconds, what is the maximum number of notes which this chord can have? If the time duration is 0.13 seconds instead of 0.08 seconds, what is the maximum number of notes which the chord can have? (Assume that it takes exactly one millisecond for a MIDI message to go through the MIDI sockets)

of all the 15 electronic keyboards.)

5. The Nyquist theorem says that the sampling rate of a digital recording or transmission should be double the highest frequency to be preserved in the recording or transmission. If, for example, the highest frequency to be preserved is f Hz, the sampling rate should be $2f$ samples per second. A Chinese orchestra concert is being digitally recorded with the highest frequency to be preserved being 17,400 Hz. What is the bit rate of the recording if the bit length of the digital samples in the digital recording is 14 bits? If the highest frequency to be preserved is 20,600 Hz instead, calculate the maximum possible bit length of the digital samples for the same bit rate. (Assume that the digital recording is in stereo, with two audio channels of equal bit rates to be digitally recorded.)

Scientific Inquiry discussion points

- (a) The invention of sound recording by Edison and others, and of radio transmission later, made it possible for music to be recorded and heard by many more listeners than hitherto. This was multiplied greatly and the fidelity of the recordings vastly improved when digital transmission and recording, coupled with smartphones and the Internet, made both live and recorded music easily accessible to a large proportion of the world's population. Hence the societal impact of science and technology can indeed be immense. Can you cite other scientific and technological innovations which had a similar or greater impact on society?