

Tutorial No 5, Semester 1, 2024/2025

1. The first 10 notes of the chorus of a well-known Singapore National Day song are: C4, D4, E4, D4, C4, D4, E4, F4, E4 and D4. What are the MIDI key numbers for these 10 notes? Give the paper roll track numbers for the first 10 notes of this song which is to be played by a player piano using a standard player piano paper roll. How, in general, can the MIDI key numbers be converted to paper roll track numbers? Starting on G4 instead of C4, give the MIDI key numbers and the paper roll track numbers for these 10 notes, assuming that the notes of the song will still have the same interval relationships with the first note.
2. A notebook computer is connected to a MIDI interface box which enables the computer to send and receive MIDI messages through MIDI in and MIDI out sockets on the interface box which are labelled IX and OX respectively. An electronic organ which has only MIDI in and MIDI out sockets labelled IR and OR respectively is used to send MIDI messages to the computer to compose a song on the computer. An electronic synthesizer 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. When the song has been completed, it is to be performed on the four electronic musical instruments (including the electronic organ). Give the connections which need to be made between the computer and the four electronic musical instruments (including the electronic organ), so that the song can be composed and then performed as desired. If the electronic organ does have a MIDI thru socket, how will this affect the required connections?

3. An electronic organ is to perform the Singapore National Day song in question 1, starting on the note C4, by sending MIDI messages from a computer through a MIDI interface box to the MIDI input of the electronic organ. The clarinet MIDI instrument in the General MIDI or GM set of the electronic organ is to play the song, and the MIDI messages are to turn each note on and off in the highest numbered MIDI channel as quickly as possible. Give the correct sequence of the MIDI messages to be sent to the electronic organ, to enable the first 10 notes of the song to be played in the correct order.
4. A desktop computer controls 14 electronic organs through MIDI cables to enable all the organs to play a piece of music together, and one particular chord is to be played simultaneously during the piece by all the 14 electronic organs. If all the 14 organs play the same number of notes of this chord, and if we assume that all the notes of the chord have to be played

within 0.12 seconds, calculate the maximum number of notes which this chord can have. If the time duration is 0.1 seconds instead of 0.12 seconds, what is the maximum number of notes that the chord can have? (Assume that it takes exactly one millisecond for a MIDI message to go through the MIDI sockets of all the 14 electronic organs.)

5. The Nyquist theorem says that the sampling rate of a digital recording or transmission is double the highest frequency to be preserved in the recording or transmission. For example, if the highest frequency to be preserved is f Hz, the sampling rate should be $2f$ samples per second. In a digital recording of a folk music concert, the highest frequency to be preserved is 16,800 Hz. If the bit length of the digital samples in the digital recording is 15 bits, what is the bit rate of the recording? If we change the highest frequency to be preserved to 19,400 Hz, what would be 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?