Tutorial No 5, Semester 1, 2024/2025

1. The first 11 notes of the chorus of a popular Singapore National Day song are: C4, C5, A4, Bflat4, C5, G4, Bflat4, A4, Bflat4, C5 and G4. 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 are the MIDI key numbers converted to paper roll track numbers in general. If we start on F4 instead of C4, what would be 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 with the first note?

2. A notebook computer is connected to a MIDI interface box, enabling 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 keyboard which has only MIDI in and MIDI out sockets labelled IK and OK respectively sends MIDI messages to the computer enabling a song to be composed on the computer. An electronic piano has MIDI in, MIDI out and MIDI thru sockets labelled IP, OP and TP respectively, an electronic tone generator has MIDI in, MIDI out and MIDI thru sockets labelled IG,

OG and TG respectively, and an electronic organ has MIDI in, MIDI out and MIDI thru sockets labelled IR, OR and TR respectively. The completed song is to be performed on the four electronic musical instruments (including the electronic keyboard). Give the connections which need to be made between the computer and the four electronic musical instruments (including the electronic keyboard) to enable the song to be composed and then performed as desired. If the electronic keyboard has a MIDI thru socket, how are the required connections affected?

3. MIDI messages are to be sent to a synthesizer to play the first 11 notes of the National Day song in question 1 on the clarinet MIDI instrument in the highest MIDI channel, turning the notes on and off as fast as possible, and starting from the note C4. What are the MIDI messages which should be sent?

4. 13 electronic pianos are connected through MIDI cables to a notebook computer to enable all the pianos to play a piece of music together, and a certain chord in this piece is to be played simultaneously by all the 13 electronic pianos. Assuming that all the 13 pianos play the same number of notes of this chord, and also that all the notes of the chord have to be played within 0.14 seconds, what is the maximum number of notes which this chord can have? If the time duration is 0.11 seconds instead of 0.14 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 sampling rate of a digital recording or transmission is double the highest frequency to be preserved in the recording or transmission, according to the Nyquist theorem. If, for example, the highest frequency to be preserved is f Hz, the sampling rate should be $2f$ samples per second. A jazz concert is being digitally recorded with the highest frequency to be preserved being 18,200 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 changed to to 16,600 Hz, 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 pro-

portion 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?