Module Title: Music Informatics
Exam Diet (Dec/April/Aug): April 2004
Brief notes on answers:

1. (a) The inter-onset interval is the time interval between the start of one musical event (note) and the next. Measure these intervals for a window in the music, and look for clusters at small integer multiples. The centre of the cluster (in chosen range, eg 60–120 bpm) gives the local tempo.

   (b) The rhythmic structure is organised around a regular low-level pulse; these pulses are grouped successively in groups of 2,3 or 4 for several levels. For full credit, note that even strong beats need not correspond to any musical onset.

   (c) The task of score following is to compute a best estimate of at what point of a score a performance has reached at any given time. To deal with ornamentation, wrong or repeated notes, can use a HMM that allows for expected transitions with high probability and "wrong transitions" with low probability.

   (d) There are variations on how such an array is laid out; need to explain that the intervals are used successively in the two dimensions. because the intervals are in terms of fifths, the notation will be different in different parts of the array (eg between b♭, a♯). Given a set of pitches, find where they fit most compactly on the array, and use the notation from that region.

   (e) Several possible rules, eg that given 4 notes with pitch interval between 2 and 3 greater than that between 1,2 and 2,3, a break is possible between 2,3. Example needed.

   (f) The notion of signature is dependent on a measure of similarity between small portions of music; identity is one case, transposition another, with more loose connections also in this case. To find a signature, try matching for similarity between minimal sized chunks from one piece against anything in any other piece. If chunks are similar, extend to maximal similar chunks, and look for other occurrences.

   (g) Possible representation: for each note, record of start time, end time, pitch (and maybe intensity, timbre), with times in seconds from start, and pitch in hertz. Alternatives use quantised pitch in semi-tones, and perhaps additional information such as pitch interval from previous note. An entropy calculation wrt particular pieces gives a measure of how compressible the data is, and thus how well-suited the representation is to the music at had.

2. (a) A p-c set is an abstraction of a set of musical pitches, which takes pitches (i) modulo the octave; (ii) arranged so that the pitches are within the smallest possible pitch range give (i); (iii) also modulo inversion of the pitch classes (intervals down rather than up), and (iv) transposed so that lowest note in C. [Bookwork]   [4 marks]

   (b) (Problem solving). An inefficient method follows the definition closely. Assume both sets of pitches have same number of pitches.

   ```
   To check identity without inversion:
       for each pitch p1 in first set
   ```

i

```
        for each pitch p2 in second set
            transpose second set so that p2 = p1
            check each pitch in first set corresponds
            to transposed pitch in second set, modulo octave
    To check identity:
        check without inversion
        ORELSE invert second set of pitches
            check that against first set withot inversion
```

(drop 2 marks if inversion not dealt with) [*5 marks*]

(c) Sketch an algorithm which searches exhaustively for matches of smallest classes (size 3 usually), extends the matches as much as possible when found, and removes all matches from the input before searching for the next significant p-c set. The final analysis should show the linear progression of the melody with [*4 marks*] repeated p-c sets aligned vertically. [*1 mark*]

(d) The definition of p-c set carries over as before, since there is no special role for the semi-tone, only recognition of when intervals are the same, and inversion which also carries over. The number of distinct p-c sets is much larger here; [*3 marks*] largest number of sets in basic theory is when sets are of 6, so here of size 12. A very rough estimate comes from thinking of successive intervals in the sets; this suggests comparing 3^5 to 6^{11}. Credit for plausible attempt to quantify this in any way. [*2 marks*]

(e) This is more open. A pass will distinguish the specifically tonal layers of L&J from other aspects. Segmentation, for example, is similar – nothing tonally specific in that part of the system. For more credit, discuss rhythmic aspects (here particular styles become relevant, but usually L&J metrical analysis is not appropriate). There is scope for prolongational level to apply, with appropriate reading of the rules. [*5 marks*]

3. (a) Standard distinction between knowing that and knowing how; this should be cashed out in terms of the task at hand. [Bookwork] [*3 marks*]

(b) Need a knowledge base (symbolic representation of rules of harmony); designer has to hand-code these rules, got from harmony texts, and study of examples in the style;
Also inference engine that will make use of the rules in order to solve a given problem. Here designer can lean on hints as to order in which the solution is constructed.
For full credit, mention possibility of user control of search for solution. [*4 marks*]

(c) HMM can be trained to give predictions of harmonic flow by looking at examples (appropriately). Details of what is involved needed for full credit. [*2 marks*]

(d) This is more open. 2 marks for example (voice-leading has turned out to work better with rule-based approach, eg). 2 marks for plausible suggestions as to what is going on (which is not in fact clear); eg given the amount of data available, harmonic progressions show more repetition than voice leading;; also, harmonic progressions fit naturally into the linear pattern that HMMs expect.

(e) To pass:
mention issues of basic coordination (synchronising, imitation of rhythmic and

melodic aspects of the playing of others); also turn-taking and issues of communicating musical intention.

To get A:

suggest how some of these issues might be tackled, and mention other issues, such as the extra-musical communication involved in human improvisation, which is hard to compensate for. Expect mention of analysis of musical output to detect musical intention. *[10 marks*