Module Code: COMP 5920M01

Module Title: Scheduling **© UNIVERSITY OF LEEDS**

School of Computing **Semester Two 2019/2020**

Exam information:

- There are **4 pages** to this exam.
- Answer **ALL 3** questions, total number of marks available is **60.**
- This exam carries a weight of **60%.**
- This is an **online open book** exam.
- **Deadline** for submission of your answers is **1100 BST 29th May 2020**.

The assessment will be available for a 50-hour period. You are expected to complete the assessment during this 50-hour period. The assessment will be available on Minerva at 0900 BST on 27th May 2020. The deadline for submission is 1100 BST 29th May 2020.

Prior to and during the assessment, support will be available to you via the module Yammer group. Please check the Yammer group to see if your question has already been asked. Please refrain from contacting module staff directly regarding the assessment. During the assessment, module staff will be monitoring the Yammer group during working hours (0900-1700 BST).

You are expected to submit your assessment submission via Minerva before the specified deadline. The submission process is the same as for your coursework assignments. If you are unable to make the submission before the deadline, then you should contact the SSO <sso@comp.leeds.ac.uk> explaining which assessment you were unable to submit on time. It is your responsibility to ensure your submission has been submitted successfully.

Your submission should be in a single PDF file. You may hand write and scan your work, or you may complete your work using text processing software (Office, LaTex, etc.). Please construct the name of your PDF file by combining your family name followed by your first name. For example, someone whose family name is Smith and whose first name is John should submit a file named “SmithJohn.pdf”.

You are encouraged to check the assessment specification as soon after the release as possible. If you have any queries then please use the Yammer group to ask questions.

Question 1

(a) "Planning horizon" is how far ahead of events becoming operational when they are planned.

(i) In the context of UK rail transport, contrast the characteristics of "Long term planning" and "Very short term planning" under their respective planning horizons.

[6 marks]

(ii) Discuss how planning horizons would generally affect the approaches to scheduling real world problems.

[6 marks]

(b) The schedule of a bus vehicle can be modelled as a sequence of timetabled trips. In developing a hyper-heuristic (HH) for bus vehicle scheduling, a set of low-level heuristics (LLH) is required to operate on such sequences of timetabled trips in a working solution. Suppose the set of LLH is based on simple swapping methods similar to those employed in the VAMPIRES algorithm. Discuss a structured approach in designing the set of LLH.

[4 marks]

(c) Suppose an intelligent system is to be developed for scheduling a network of smart cameras in public places such as a large train station for surveillance purposes. Discuss the background to look for in someone to be appointed to lead this project.

[4 Marks]

[20 marks total]

Question 2

(a) Consider the modelling of train unit scheduling as a multi-commodity network flow problem.

(i) Outline the setting up of a directed acyclic graph (DAG) as the basis of the model. **[4 marks]**

(ii) Explain the main practical limitations of an optimal solution derived using this model. **[4 marks]**

(iii) Explain why the VAMPIRES algorithm for bus scheduling would not be suitable for scheduling train units. **[5 marks]**

(b) The Size Limited Iterative Method (SLIM) has been designed for solving large instances of the train unit scheduling problem. Discuss how a similar approach could be applied for solving large instances of the train crew scheduling problem. **[7 marks]**

[20 marks total]

Question 3

(a) An airline based in City A operates daily flights between some regional airports. Cabin staffs always begin their shifts at City A, and the last flights in their shifts will always return back to City A. The total number of cabin staffs (N) is fixed. More than one cabin staff may be assigned on a flight and each flight must be covered by at least one cabin staff. The cost of each cabin staff schedule is known and the airline would like to minimise the total cabin staff cost.

(i) Describe how the Generate and Select approach for train crew scheduling can be applied similarly to this airline crew scheduling problem. No detailed mathematical formulation is required.

[4 marks]

(ii) Briefly comment on whether the above airline crew scheduling problem would be more difficult to solve comparing with the crew scheduling problem for a UK regional train operating company. Assume that the Generate and Select approach is used for both problems.

[2 marks]

(iii) A train driver schedule generally consist of shifts of different lengths. The labour union for train drivers has negotiated a rule at a train crew depot *d*, which states that the average shift length for all the driver shifts at that depot must be less than or equal to α_d minutes. Suppose an Integer Linear Programme (ILP) is used in the Generate and Select approach for scheduling the train drivers, explain the pre-processing needed given the input to the ILP includes the cost c_j and length l_j of candidate shift $j \in J_d$ and the parameter α_d.

[3 marks]

(b) Discuss the challenges in deriving an optimisation algorithm for scheduling both train units and their drivers simultaneously.

[5 marks]

(c) Compare and contrast the computation and application of shortest paths in bus vehicle scheduling and train crew scheduling.

[6 marks]

[20 marks total]