

Name: \_\_\_\_\_ Student No.: \_\_\_\_\_

**SCHOOL OF CIVIL ENGINEERING  
UNIVERSITI SAINS MALAYSIA (ENGINEERING CAMPUS)  
EAL 337/3 PAVEMENT ENGINEERING (SEMESTER 1 2021/2022)**

**TEST 1**

**Answer all questions**

**Question 1**

- [a] Specify and explain **TWO (2)** types of natural binder that have been found and used for the road constructions. **(8 Marks)**
- [b] Identify **TWO (2)** examples of natural asphalt for each type specified above **(4 Marks)**
- [c] Bitumen is a visco-elastic material whose properties depend on temperature and time of loading. Describe how a bitumen will behave:
- i. when subjected to high temperature. **(2 Marks)**
  - ii. when subjected to short time of loading. **(2 Marks)**
  - iii. when combined with a soapy emulsifying agent **(2 Marks)**
  - iv. when combined with a petroleum solvent **(2 Marks)**

**Question 2**

- [a] Air Voids ( $V_a$ ) is one of the important parameters in determining volumetric properties of asphalt mixture. Based on your understanding, for dense asphalt mixture, why is it important to maintain certain percentages of air voids in compacted asphalt pavement layer. Additionally, explain the effects of having too low and too high air voids contents in the compacted asphalt pavement layer. **(6 Marks)**
- [b] Table 1 summarizes volume, density, and degree of compaction (%) for the cored asphalt pavement layer.
- i) Calculate the volume, density, and degree of compaction for sample 1. Additionally, calculate the density and degree of compaction for sample 4. **(16 Marks)**
  - ii) Determine the average degree of compaction and comments whether the value complies to the JKR's specification or not. **(8 marks)**

(Show all the formulas for and step-by-step calculations)

AC14	WEIGHT (g)			Volume (cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )	Maximum Density (g/cm <sup>3</sup> )	Degree of Compaction (%)
	Dry	Water	SSD				
1	1450.1	815.2	1450.7	?	?	2.319	?
2	1523.5	862	1533.1	671.1	2.270	2.319	97.9
3	1829.5	1026.3	1832.7	806.4	2.269	2.319	97.8
4	1291.1	732.4	1293.7	561.3	?	2.319	?
5	1418.5	803	1419.1	616.1	2.306	2.319	99.4

Figure 1. Compacted asphalt samples' parameters to determine the degree of compaction for a local road project