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B. Sc. Engg. (CEE)/ 6th Sem. 21 May, 2024, Group B

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination **Summer Semester: 2022-2023**
Course No.: CEE 4653 **Full Marks: 150**
Course Title: Pavement & Railway Engineering **Time: 3.0 Hours**

There are 7 (Seven) questions. Question No. 4, 5, 6, 7 are compulsory. Answer any 2 (Two) questions from Question No. 1, 2 and 3.

Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks along with their CO-PO. The Symbols have their usual meaning. Assume reasonable values for any missing data.

1(a) Discuss which type of pavement works suits a Sheep Foot Roller, with justification. Discuss relative advantages and disadvantages of concrete and asphalt pavement. ($7\frac{1}{2}$) (CO1-PO1)

(b) Define interlocking and state its principles. Discuss- Wayside stations, Junctions and Terminals with figures. (5+10) (CO2-PO1)

2(a) Write down the types of velocity resistances a train usually face during its operation. Discuss relative advantages of concrete sleepers over Iron Sleepers. ($7\frac{1}{2}$) (CO1-PO1)

(b) Differentiate between the following: (15) (CO2-PO1)

(i) Acute crossing and Obtuse crossings
(ii) Switch angle and Throw of switch
(iii) Cant deficiency and Negative super-elevation
(iv) Flag station and Block station
(v) Calling-on signal and Indicators

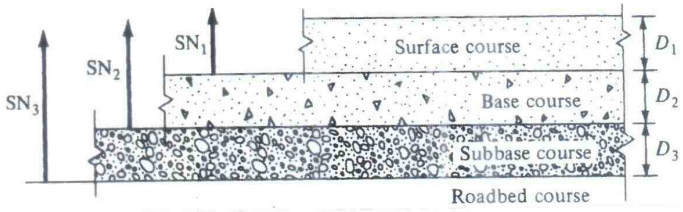
3(a) Discuss desirable properties of Ballast. Find required ballast depth if the sleeper density is M+7 on broad gauge track is M= 16 meter. ($7\frac{1}{2}$) (CO1-PO1)

(b) Write down the working principle of the following signals with figures (i) Semaphore signal (ii) Warner signal (iii) Disc signal. Find out the maximum speed of a train on a M.G. track having a curvature of three degrees and cant of 10 cm. Assume allowable cant deficiency as 75 mm. (9+6) (CO2-PO1)

4(a) Briefly state the function, requirement, and procedure for a transverse contraction joint with figure. What is pavement serviceability index and what are the factors that pavement serviceability index depends on? (8+3) (CO3-PO1)

(b) (i) It is desired to combine 30 percent of material A with 70 percent of material B to conform to the AASHTO grading B for soil-aggregate surface construction. It is noted that % passing No. 40 sieve for material A is equal by weight to the % passing No. 40 sieve for material B. Estimated liquid limit and plasticity index of the selected aggregate blend are 23.33% and 6.67% respectively. The liquid limit and plasticity index of material B is 12% and 5% respectively. Find the liquid limit and plasticity index of material A. (10+5) (CO4-PO3)

(ii)The following information are available for the design of a flexible pavement by AASHTO method.
Design ESAL=12.5 x 10^6
Reliability Level=85 percent
Standard deviation=0.45
Serviceability loss, ΔPSI=2.0
The structural numbers, layer co-efficient and drainage modifying factors are given as follows:
a_1=0.42, SN_1= 2.05, a_2=0.13, SN_2= 3.3, m_2=0.95, a_3=0.075, SN_3=6.5, m_3=0.90
Find the layer thickness. Assume reasonable value of missing data, if any.



$D_1 >= SN_1 / a_1$
$D_2 >= (SN_2 - a_1 D_1'') / a_2 m_2$
$D_3 >= (SN_3 - a_1 D_1'' - a_2 D_2'' m_2) / a_3 m_3$

5(a) What are the two stress-strain conditions on which 'The Asphalt Institute' method of flexible pavement design is based? Explain with figures. What are the effects of temperature and moisture on flexible pavement design? (7+4) (CO3-PO1)

(b) Describe AASHO road test. What are the design steps for the thickness design of concrete pavement as per PCA method? Refer to the following data (5+3+7) (CO4-PO3)
Four-lane, two-way current traffic (ADT)=3410
Volume of truck traffic=60 percent
Percentage of truck using design lane=80
For a 10 year design period, projection factor=2.5
Modulus of rupture of concrete=650 psi
Combined modulus of subbase-subgrade, k=130 pci
For an assumed thickness of 9.5 inches, the total fatigue and erosion damage are calculated to be 62.8 and 38.9 respectively for single and tandem axles.
(i) Calculate the total number of trucks in the design lane.
(ii) Check whether the assumed thickness is OK or not. Assume reasonable value of missing data, if any.

6(a) It is obtained that the effective resilient modulus of the roadbed soil is 5000 psi for average relative damage of 0.31. The relative damage values for the first 11 month of a year (Jan-Nov.) were as follows: (11) (CO3-PO1)

Month	Relative Damage
January	0.01
February	0.01
March	1.51
April	0.51

May	0.51
June	0.13
July	0.13
August	0.13
September	0.13
October	0.13
November	0.51

What would be the value of the relative damage ratio for the month of December? Explain principle, material requirement and construction steps for bituminous soil stabilization? Differentiate between Water-bound macadam and Bituminous macadam.

(b) As a consultant, you are requested to troubleshoot several types of asphalt mixes, each showing one or more issues. Provide preliminary solution for following mix issues: (15) (CO4-PO3)

i. High Flow and high stability
ii. Low flow but high void
iii. Low voids and good stability
iv. High void and low density
v. High flow and low density

7(a) Estimate Life Cycle Cost of the following 5-km road infrastructure over 10-year design life for a discount rate of 5%: (12) (CO3-PO1)

- Initial Construction Cost (0^{th} year): $20 million
- Yearly Maintenance cost (pothole repair, seal coating): $1 million
- Major Repair each 4^{th} Year (new wearing course on 4^{th} and 8^{th} year): $5 million
- End of Life Salvage Value (10^{th} year): $5 million
- Due to poor road condition, accidents cause $2 million cost on 3^{rd} and 7^{th} year.

(b) An asphalt mix is being optimized using Marshall method. Using a given job mix composition, several lab specimens were prepared and tested using the Marshall method. Determine optimum bitumen content, VMA, air voids for the mixes with different bitumen content for mix design purpose and comment on the values obtained. (15) (CO4-PO3)

Aggregate	**%Weight in mix**	**Bulk specific gravity**		
Course	45%	2.68		
Fine	50%	2.70		
Filler	5%	2.58		
Bitumen Content	**Bulk Density (Kg/cu.m.)**	**Stability (kN)**	**Flow (mm)**	**Gmm**
4%	2350	8.44	2.6	2.54
4.5%	2390	8.68	2.8	2.58
5%	2420	8.75	3.1	2.59
5.5%	2390	8.54	3.3	2.59