Module (Course Syllabus) Catalogue

2024-2025

College/ Institute	**Erbil Technical Engineering College**				
Department	**Highway Engineering Department**				
Module Name	**Asphalt Technology**				
Module Code	**AST303**				
Degree	**Technical Diploma**		**Bachelor**	*	
	High Diploma		**Master**		**PhD**
Semester	**3rd**				
Qualification	**Master degree**				
Scientific Title	**Assistant Lecturer**				
ECTS (Credits)	**6**				
Module type	**Prerequisite**		**Core**	*	**Assist.**
Weekly hours	**5**				
Weekly hours (Theory)	**(3) hr Class**	**(162) Total hrs Workload**			
Weekly hours (Practical)	**(2) hr Class**				
Number of Weeks	**16**				
Lecturer (Theory)	**Bafreen Chalabi Zero**				
E-Mail & Mobile NO.	**bafrin.chalabi@epu.edu.iq/0750 451 42 14**				
Lecturer (Practical)	**Bafreen Chalabi Zero**				
E-Mail & Mobile NO.					
Websites					

Course Book

<table>
<tr><td>Course Description</td><td colspan="5">The Asphalt Technology has divided into two parts, theoretical and laboratory parts. Theoretical Surveying lectures will help students to learn and easily recognize of the Asphalt Technology such as. Classification and sources, Manufacturing method, Fractural compounds, Rheological properties, Paving materials, Paving requirements, Mineral aggregate, Mixture volumetric analysis, Asphalt mix design methods and HMA manufacturing plants.</td></tr>
<tr><td>Course objectives</td><td colspan="5">The main goal of this module is to provide a good understanding of the asphalt materials and processes used in design and manufacturing asphalt pavement. Likewise, it aims to illustrate the emerging role of recent developments in the context of distresses by improving characteristics of the mixture as follows: identifying potential and complex material behaviors. Additionally, this module appreciates the role of modification techniques with in polymer modified bitumen (PMB) and its consequences.</td></tr>
<tr><td>Student's obligation</td><td colspan="5">The students should be a viable during lecture time table when the student absent more Than the allowed hours the student will be dismissed. Students should be doing quizzes, practical reports, seasonal tests and final exams in order to able to collect required mark to success.
All students are required to fulfil the following requirements:
➢ Attendance
➢ Participation in problem solving and class activities
➢ Doing homework
➢ Participation in quiz
➢ Participation in exams
➢ Conducting projects
➢ Presenting seminars
➢ Preparing reports</td></tr>
<tr><td>Required Learning Materials</td><td colspan="5">During lecturing the data show is used for showing lecture notes using power point program while the white board is used for explanation, tutorial videos and solving problems.</td></tr>
<tr><td rowspan="9">Evaluation</td><td colspan="2">Task</td><td>Weight (Marks)</td><td>Due Week</td><td>Relevant Learning Outcome</td></tr>
<tr><td colspan="2">Paper Review</td><td></td><td>Depending on activity given</td><td>Each activity will give storm braining and additional knowledge to the subject</td></tr>
<tr><td rowspan="6">Assignments</td><td>Homework</td><td>5%</td><td></td><td></td></tr>
<tr><td>Class Activity</td><td>2%</td><td></td><td></td></tr>
<tr><td>Report</td><td rowspan="4">10%</td><td></td><td></td></tr>
<tr><td>Seminar</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td></td></tr>
<tr><td>Project</td><td></td><td></td></tr>
<tr><td colspan="2">Quiz</td><td>8%</td><td></td><td></td></tr>
</table>

	Lab.	10%		
	Midterm Exam (Theory)	10%		
	Midterm Exam (Pract.)	15%		
	Final Exam(thr)	20%		
	Final Exam(pract.)	20%		
	Total	100%		

Specific learning outcome:	One basic and very important objective of study Asphalt Technology is: The Asphalt Technology lectures will help students to learn and easily recognize of the Asphalt, which it is relate to all of the highway engineering especially for pavement design.
Course References:	➢ Thom, N.H. (2008) 'Principles of Pavement Engineering', Thomas Telford. ➢ The Shell Bitumen Handbook', Thomas Telford, 2003. ➢ Lavin, P. G. (2003) Asphalt Pavements: Apractical guide to design, production and maintenance for engineers and architects. 1st edn. London: Spon Press. ➢ Robinson, H. L. (2004) 'Polymers in Asphalt'. Rapra Review Report 15 (11), 23-29. ➢ Mallick, R. B. and El-Korchi, T. (2013) 'Pavement Engineering Principles and Practice', CRC Press. ➢ Huang, Y. H. (2012) 'Pavement Analysis and Design', 1st edn. USA: Pearson. ➢ Nicholas J. Garber and Lester A. Hoel." Traffic and Highway Engineering", Fourth Edition. ➢ Yoder; E. J. and M. W. Witczak, "Principles of Pavement Design", A Wiley-Interscience Publication, John Wiley & Sons Inc., U.S.A., 1975. ➢ Yaug H. Huang, "Pavement Analysis and Design", Prentic Hall Inc., U.S.A., 1993. ➢ "AASHTO Guide for Design of Pavement Structures 1993", AASHTO, American Association of State Highway and Transportation Officials, U.S.A., 1993. ➢ Oglesby Clarkson H., "Highway Engineering", John Wiley & Sons Inc., U.S.A., 1975.

Course topics (Theory)	Week	Learning Outcome
Introduction to Asphalt Production	1	• Be informed to a historical background with some definitions and Classifications. • Learn about different types of binders used in asphalt pavement construction. Learn the steps of Refinery Process of Crude Oil Distillation particularly asphalt production.
Fractional Compounds of Bitumen and Temperature Susceptibility and Gradation of Bituminous Binders	2	• Understand the chemical composition of bitumen • Learn about the determination of important characteristics of bituminous binders which affect pavement performance. • Learn how temperature susceptibility of bitumen can be worked out. • Learn how temperature susceptibilityof bitumen can be worked out. • Learn how pavement grade bitumens are produced

Rheological Properties of Bitumen: Viscoelastic Behaviour and Simple Mechanical Modeling and Hot Mix Asphalt (HMA) Types, Mechanical Properties & Performance Tests	**3**	• Learn about the determination of important characteristics of bituminous binders which affect pavement performance, depending on the different simple mechanical models. • Appreciate the bitumen behavior and its mechanical properties of mixtures and their performance in several performance tests Learn about the different typical asphalt mixes and their characteristics which may affect pavement performance, depending on their components.
Mineral Aggregate Used in Asphalt Mixes And Hot Mix Asphalt (HMA) Volumetric Properties and Analysis	**4** **5**	• Learn about the types & sources of paving aggregates • Learn about the relevance of different properties of these aggregates for pavement performance and their determination • Learn about mineral aggregates (coarse & fine) used in asphalt mixes and their gradations as well as calculations. • Learn importance of the HMA volumetric **properties** and **terms** for mix design stand point (including performance) and field construction standpoint. Understand the important factors which can influence key mass-volume relationships and calculations.
Mixture Design And Flexibale Pavement Distresses	**6** **7**	• Develop the essential understanding of flexible pavement deteriorations. • Appreciate that there has to be a decent understanding of why do asphalt defects occur. • Learn about the diverse types of distresses, concept of their causes and cures. • Learn about the principal procedure and concept used in Marshall design method . Appreciate the fundamental advantages and disadvantages of Marshall design method compared with its equivalent and recent methods of design.
Hot Mix Asphalt (HMA) Production and Placement and Superpave Mix Design: Performance Grade (PG) Asphalt Binder	**8** **9** **10**	• Develop an essential understanding and requirements of the HMA production, delivery/transport, placement and compaction. • Learn different types of HMA plants and their configurations. • Develop an essential understanding including the requirements and main considerations of Performance graded asphalt (PG). • Learn superpave binder specifications & selections with respect to temperature and its associated new testing system. Learn the main understanding of aging process undertaken on bitumen.

Performance of Polymer Modified Bitumens (PMBs) And Use of recycled materials in road construction	**11** **12**	• Develop the essential understanding of PMBs • Appreciate the need for Modified Asphalts • Learn the classification and their chemical & physical composition • Learn that polymers can change the characteristics of bitumen dramatically at low modification levels reducing the amount of waste sent to landfill, reducing illegal dumping and littering, reducing the greenhouse gas emissions generated by the production of new materials and the disposal of waste materials, reducing our reliance on non-renewable resources, and developing a circular economy where materials are continually reused in their highest and best use.
Practical Topics	**Week**	**Learning Outcome**
1. Specific Gravity Test	**1**	Specific Gravity Test of Bitumen is determining the specific gravity of bitumen which one of the fundamental properties of bitumen. It can therefore be used in the classification of bitumen binders used for pavement construction.
2. Penetration Test 3. Softening Point Test	**2**	• The softening point is also an indicative of the tendency of the material to flow at elevated temperature encountered in service. For calculate the penetration index (PI) of the grade asphalt.
4. Ductility Test	**3**	• The test is believed to measure the adhesive property of bitumen and its ability to stretch. This test is intended to determine the
5. Flash and Fire Points Test	**4**	• temperature to which the materials may be heated safety for construction purpose. The flash point test is sometimes used to determine the existence of impurities like gasoline or kerosene in the materials.
6. Viscosity Test •Saybolt-Fural Viscosity Test •Kinematics Capillary Viscosity Test	**6**	To determine the viscosity of bitumen
7. Loss of Heating Test •Thin Film Oven Test •Rolling Thin Film Oven Test	**8**	Short term aging of asphalt.
8. Los Angeles Abrasion Value of Aggregate Test	**9**	• Abrasion test is carried out to test the hardness property of aggregates.

		The size distribution is often of critical
9. Sieve Analysis (Gradation)Test	**10**	importance to the way the material performs in use.
10. Mix Design Test	**11** **12**	• To prepare standard specimens of asphalt concrete for measurement of stability and flow in the Marshall apparatus. • To determine density, percentage air voids, and percentage of aggregate voids filled with binder. To find the optimum binder content in the mix.

Questions Example Design

All questions are numerical and problem-solving types. An example of a question paper and its solutions are attached at the end of this file.

Extra notes: Students can use internet for more explanation and getting extra examples.

External Evaluator

I confirm that all syllabuses given in the attached course book is sufficient to covers required subjects, areas and titles needed for students.

د.ي.ث ناارس حممد جاسم

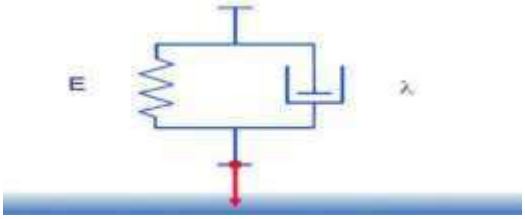
Examinations (question design), Sample of Exam:

Ministry of Higher Education & Scientific Research **Erbil Polytechnic University** **Erbil Technical Engineering College** **Civil Engineering Department** **Note:**	**2022 - 2023** **Final Examination**	**Class: Second** **Subject: Asphalt Tech.** **Time : 2 hrs.** **Date : 8/1/2023** **Code: AST305** **1st Attempt**

Theoretical part

Question 1 — 25 Marks

For the figure shown below, drive an expression representing the result of viscoelastic response of the bitumen after applying creep stress on it? Explain each step in your answer.



Question 2 — 25 Marks

A. What are the reasons of aggregate blending from different stockpiles? Explain its methods and required formula.

B. Explain what is meant by the terms curing when referring to cutbacks? List their types and solvent used for each. Write the properties of the one that its recommended for aggregates having more than 20% fine aggregate.

Question 3 — 25 Marks

A. Explain the main properties of stone Mastic Asphalt (SMA)? Show its composition in a diagram.

B. Explain briefly with the aid of diagram, the main steps of crude oil fractional distillation process, in which bitumen is produced and explain the term Bottom of the Barrel.

Question 4 — 25 Marks

For the sample of tested bitumen that has frequency of 10HZ and initial penetration of 40 mm.

Determine the stiffness of the bitumen for a specific road if the interested temperature is 25°c?

Pr= 0.65*Pi ; t=1/v or t =1/f

SPi= 98.4-26.35log10Pi; SPr= 98.4-26.35log10Pr

PIr= [(27log10Pi-21.65)/(76.35log10Pi-232.82)]

Sb= 1.157 * 10-7*t-0.368*2.718-P.Ir*(SPr-T)5

Practical part

Question 1 — 5 Marks

Define the following mention:

Ductility, Flash and Fire Point and Softening Point

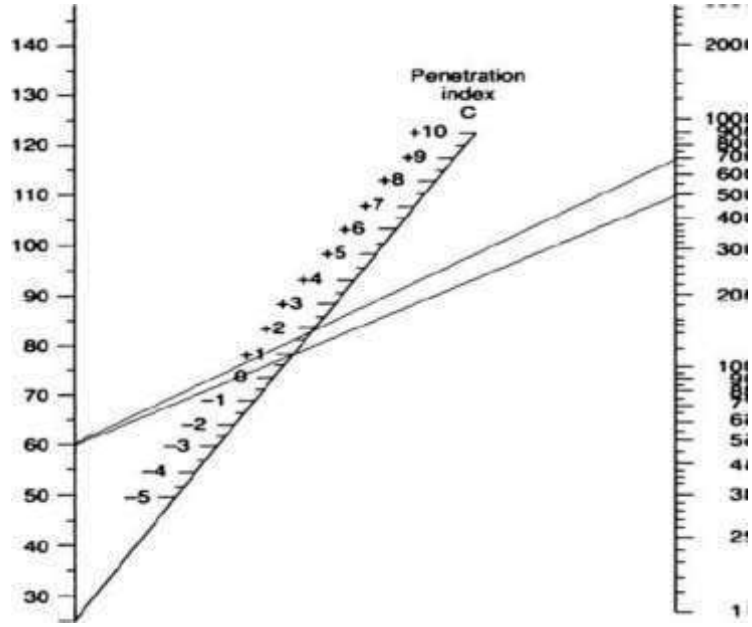
Question 2 — 5 Marks

If Softening point equal to (45°C-55°C) and Penetration at 25°C, 100g, 5s equal

to (60-70) find the Penetration Index by Graph and equation after that comparison different between them?

Question 3 — 5 Marks

What are the important factor effect on the asphalt material in field?

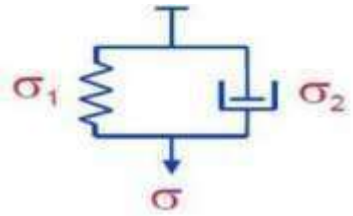


GOOD LUCK

Lecturer Name: Miss. Bafreen Chalabi

Answer:theoretical part: Question 1

$$\sigma(\text{total}) = \sigma_1(\text{elastic}) + \sigma_2(\text{viscous})$$



Differentiate

$$\frac{d\sigma}{dt} = \frac{d\sigma_1}{dt} + \frac{d\sigma_2}{dt}$$

Elastic (spring)

$$E = \frac{\sigma_1}{\varepsilon} \quad \therefore \quad \frac{d\sigma_1}{dt} = E\frac{d\varepsilon}{dt}$$

Viscous (dashpot)

$$\lambda = \frac{\sigma_2}{\frac{d\varepsilon}{dt}} \quad \therefore \quad \frac{d\sigma_2}{dt} = \lambda\frac{d^2\varepsilon}{dt^2}$$

Constant stress, σ, therefore $\frac{d\sigma}{dt} = 0$

$$\therefore \quad E\frac{d\varepsilon}{dt} + \lambda\frac{d^2\varepsilon}{dt^2} = 0$$

Solution of this differential equation

$$\varepsilon(t) = \varepsilon_o(1 - e^{-\frac{Et}{\lambda}}) \qquad \tau = \frac{\lambda}{E}$$

$$\therefore \qquad \varepsilon(t) = \varepsilon_o(1 - e^{-\frac{t}{\tau}})$$

Divide by constant stress, σ, to obtain creep compliance, J.

$$J(t) = J(1 - e^{-\frac{t}{\tau}})$$

Question 2

A. Reasons for Blending from Different Stockpiles

Obtain desirable gradation

Single natural or quarried material not enough

Economical to combine natural and process materials

Blending of Aggregate

Try and error method

General form aX1+bX2+cX3+dX4…….= T

Where;

X1,X2,X3 are % passing or retaining from each type of aggregate on each sieve size.

a, b, c are unknown parameters for % passing or retaining; in which a+b+c=1

T is the specification limit (for 1st trial used midpoint)

Typical Asphalt Mixes –Stone Mastic Asphalt (SMA)

B. Application of Cutbacks

Curing is the evaporation of solvent from cutbacks

1. RC is recommended for surface dressing and patch work recommended with aggregates containing particularly no fine aggregates (passing 2.36mm sieve).

2. MC is recommended for aggregates having less than 20% fine aggregates.

3. SC is recommended for aggregates having more than 20% fine aggregates.

Question 3

A.•Gap grading; large stones form skeleton; the rest fill the voids

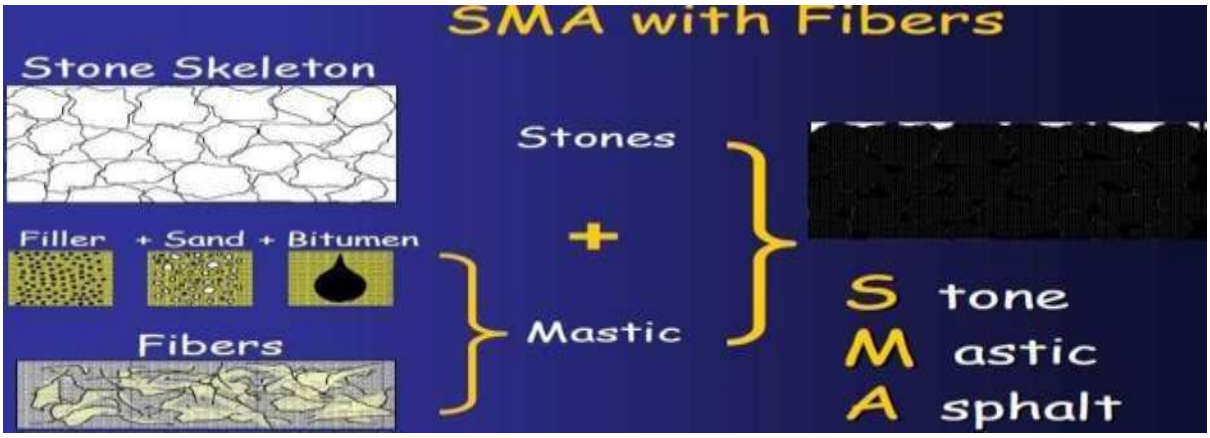
•Medium bitumen content

•Critical that mix is correctly proportioned

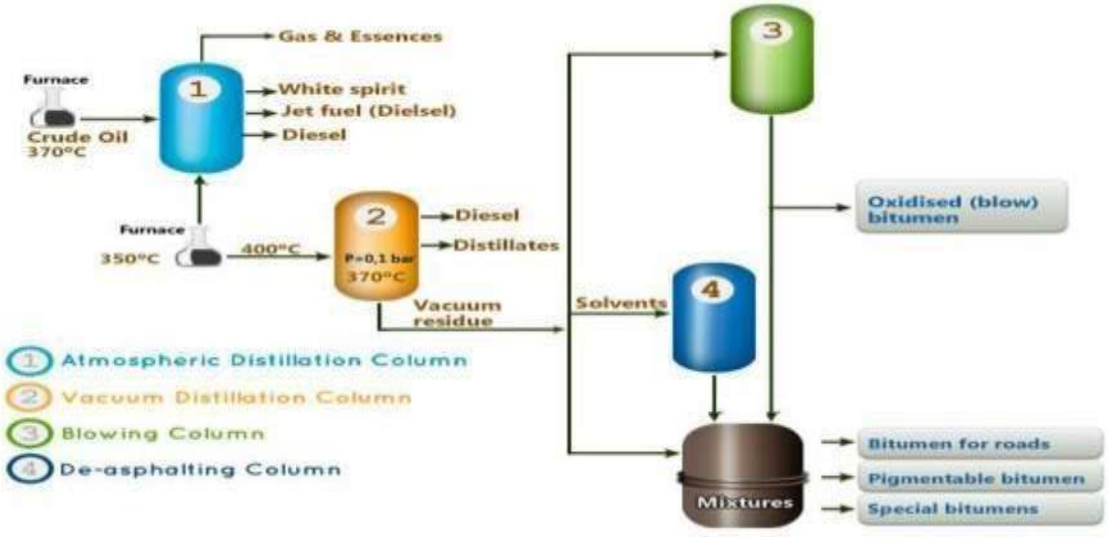
•Used for surface only (wearing)

•SMA is a gap-graded HMA that is designed to maximize deformation (rutting) resistance and durability by using a structural basis of stone-on-stone contact

•Because the aggregates are all in contact, rut resistance relies on aggregate properties rather than asphalt binder properties.



B.



Question 4

t = 1/10 = 0.1 sec
Pr = 26 dmm
SPr = 61.12
Plr = -0.195

Sb = 20.17 MPa

Practical part

Question 1 Ductility: The distance @ which bitumen elongates before it breaks @ a constant temperature.

The Flash Point of a bitumen material is the temperature at which the substance momentarily takes fire in the form of a flash for a second under specified test conditions.

The Fire Point of a bitumen material is the lowest temperature at which the materials get ignited and burns on the surface continuously for 5 second under specified test conditions.

Softening point: is the temperature in which bitumen change from solid to liquid.

Question 2

PI = +2.8 and PI = +0.5 by graph

Question 3

Tamprture , quality of lab, type of material, person of working in lab, and location.

GOOD LUCK

Lecturer Name: Miss. Bafreen Chalabi