FACULTY OF ENGINEERING

B.E. 4/4 (Civil) II – Semester (Old) Examination, May 2013

Subject: Health Monitoring and Retrofitting of Structures (Elective – II)

Time: 3 Hours   Max.Marks: 75

Note: Answer all questions from Part A. Answer any five questions from Part B.

PART – A (25 Marks)

1	Why is it required to monitor the health of a structure?	(2)
2	Compare SHM and Bio-mimetics.	(3)
3	Sketch the arrangement of a probe in a capacitive method.	(3)
4	What is a capacitive method?	(2)
5	What is the importance of visual inspection?	(3)
6	Mention any two applications of Infra red thermography.	(2)
7	What do you understand by 'quality control' of concrete structures?	(3)
8	What is 'non-destructive evaluation' of a concrete structure?	(2)
9	Explain the importance of re-analysis in seismic retrofitting.	(3)
10	Explain the difference between 'repair' and 'rehabilitation'.	(2)

PART – B (50 Marks)

11 Explain the role and importance of all the basic components of a 'Structural Health Monitoring System'. (10)

12 Referring to a historical building of your city, explain the implementation of 'SHM' that you propose. (10)

13 Explain in detail the application of 'Ground penetrating Radar' test for a pre-stressed concrete bridge structure. (10)

14 What are the objectives of a condition survey? Explain the various stages of condition survey as applied to an earthquake hit multi-storeyed concrete structure. (10)

15 What are the common defects in concrete structures? How are they avoided using quality control methods? (10)

16 Explain how the modelling of a repaired composite structure is done clearly mentioning the important parameters considered in modelling. (10)

17 Write short notes on the following:
   (a) Materials for sensor design (3)
   (b) NDT v/s NDE (3)
   (c) Seismic Retrofitting strategy (4)

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FACULTY OF ENGINEERING
B.E. 4/4 (Civil) II - Semester (New)(Main) Examination, May 2014

Subject : Health Monitoring and Retrofitting of Structures (Elective-II)

Time : 3 Hours   **Max. Marks: 75**

Note: Answer all questions of Part - A and answer any five questions from Part-B.
PART – A (25 Marks)

1	Define SHM	(2)
2	Write about capacitive methods	(3)
3	What you mean by NDT, classify NDT procedures?	(3)
4	Explain Rebound Hammer Test.	(3)
5	Condition survey and NDE of concrete structure – Explain the Terms.	(3)
6	NDE-Explain the term and applications of NDE.	(3)
7	Explain the different between Rehabilitation and Retrofitting.	(2)
8	Define Restoration and Rehabilitation.	(2)
9	Explain different between passive SHM and active SHM.	(2)
10	Explain SHM as a part of nervous system.	(2)

PART – B (50 Marks)

11 Explain the procedure of Schmidt Rebound Hammer Test and Ultrasonic test used for concrete Testing.   (10)

12 Explain SHM, NDE, NDECs' terms and a way for smart materials and structures.   (10)

13 SHM of a bridge applications for external post tensional causes, explain.   (10)

14 (a) Explain NDT classification and NDT procedures.   (5)
   (b) Half cell – electrical potential methods, explain with neat sketches.   (5)

15 Write a report on Retrofitting and Rehabilitation of structures by referring to a case study.   (10)

16 Methods of Repairs to structures, modeling of repairal composite structures, explain with a case study.   (10)

17 Write short notes on the following: (10)
   (a) Electromagnetic methods
   (b) Radio isotope gauges
   (c) Ground penetrating Radar

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FACULTY OF ENGINEERING
B.E. 4/4 (Civil) II – Semester (Old) Examination, May 2014

Subject: Ground Improvement Techniques (Elective – II)

Time: 3 Hours   **Max.Marks: 75**

Note: Answer all questions from Part A. Answer any five questions from Part B.
PART – A (25 Marks)

1   The mechanical stabilization method include removal of a specific sized particles from the in-situ soil. Answer yes or no and justify your answer.   (2)

2   When a plastic clay is stabilized with lime, its plasticity index (PI) will increase. Answer yes or no and justify your answer.   (2)

3   If soil in a zone of 9 m from the ground level is proposed to be improved by blasting technique, suggest the depth from ground level at which the charge (blast material) is to be placed. Justify your answer.   (2)

4   Preload is not required when vertical drains are used. Answer yes or no and justify your answer.   (2)

5   A $\Phi=0$ soil is most suitable as a fill material in construction of reinforced earth retaining walls. Answer yes or no and justify your answer.   (2)

6   What is significance of specific surface of the in-situ soil in deciding the quantity of Cement to be admixed in the cement stabilization method? State the typical range of quantity of cement suggested for major types of soils.   (3)

7   The hydro-fracture aspect of grouting is possible in cohesionless soils. Answer yes or no and justify your answer.   (3)

8   Differentiate vibro-compaction with vibro-replacement compaction and suggest the relevant methods.   (3)

9   The primary consolidation settlement of a fully saturated compressible clay undergoing consolidation process aided with sand drains is found to be 0.96 m. If, after six months, the degree of consolidation pertaining to vertical and radial drainages is 28% and 58% respectively, determine the magnitude of settlement at this stage.   (3)

10 Explain the significance of Anchorage length in the design of reinforced earth retaining walls   (3).

PART – B (5 x 10 = 50 Marks)

11 (a) A residential G+4 multi storied RCC framed structure provided with nominal isolated footings without proper evaluation of bearing capacity of the ground was constructed up to G+2. At this stage, the geotechnical investigations conducted at that site in the close proximity of existing foundations revealed that, the bearing capacity is inadequate for G+4. Analyze the site condition and suggest the ground improvement technique that can enhance the bearing capacity of the ground for G + 4 without disturbing the existing footings.   (5)

(b) Explain the principle and procedure of mechanical stabilization. (5)

12 (a) Write a detailed note on Bitumen stabilization. (5)
   (b) Describe the requirements of a good grout material. Explain the classification of grout materials. (5)

13 (a) Explain the mechanism of in-situ densification of cohesionless soils in dry, partially saturated and fully saturated states, using vibration methods. (5)
   (b) Describe the "Vibro-floatation" technique including its merits and demerits. (5)

14 (a) Explain the dewatering methods in detail and how they help in ground improvement. (5)
   (b) Compare conventional sand drains with pre-fabricated vertical drains. (5)

15 (a) Write a note on applications of geosynthetics in "Geoenvironmental Engineering". (5)
   (b) Describe the components of a Reinforced soil retaining wall with the help of a neat sketch and explain the functions served by those components. (5)

16 (a) Write a detailed note on quality control aspects in soil stabilization. (5)
   (b) Describe blasting technique and comment on its merits and demerits. (5)

17 Write a note on any TWO of the following: (2 x 5 = 10)
   a) Thermal methods
   b) Aspects of grouting
   c) Functions of geotextiles
   d) Dynamic consolidation

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FACULTY OF ENGINEERING
B.E. 4/4 (Civil) II – Semester (Old) Examination, May 2014

Subject: Advanced Environmental Engineering
(Elective – II)

Time: 3 Hours   Max.Marks: 75

Note: Answer all questions from Part A. Answer any five questions from Part B.
PART – A (10 x 2½ = 25 Marks)

1   List out the effects of industrial effluents on land.   (2)
2   What should be the effluent characteristics of thermal power plant?   (3)
3   Define: Stack sampling, lapse rates.   (2)
4   State the factors affecting the selection of proper equipments.   (3)
5   State the limitations of environmental impact assessment.   (3)
6   Draw the wind rose diagrams.   (2)
7   Show the manufacturing process by means of sketch for pharmaceutical industry.   (2)
8   Explain the principle involved in control of suspended particulate matter for any air
    pollution equipments.   (3)
9   State the concept of atmospheric stability.   (2)
10 List out the important points that need to be included for preparation of Environmental
    Management Plan.   (3)

PART – B (5x10 = 50 Marks)

11 (a) Explain in detail the parameters of environmental legislation related to hazardous
         wastes.
    (b) Write a short note on self-purification of water bodies.

12 Enumerate the limits of waste water and effluent characteristics of cement and sugar
    industry.

13 (a) Give the detailed classification of air pollutants.
    (b) Explain in detail the process involved in ambient air quality monitoring.

14 (a) Describe the control methods used for gaseous pollutant.
    (b) Enumerate the various methods of air pollution control.

15 (a) State in detail the various legal provisions of Environmental Impact Assessment.
    (b) What do you understand by Environment Management Plan?

16 (a) List out the various important points involved in the baseline data collection
         required for EIA.
    (b) Give the classification of various industries which release waste into streams.

17 Write a detailed note on the following:
a) Streeter Phelps Equation   b)   Issues related to rehabilitation of affected people.

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FACULTY OF ENGINEERING
B.E. 4/4 (Civil) II-Semester (New)(Main) Examination, May 2014

Subject : Advanced Environmental Engineering (Elective-II)

Time : 3 Hours   **Max. Marks: 75**

Note: Answer all questions of Part - A and answer any five questions from Part-B.
PART – A (25 Marks)

1	Give the detail classification of industries.	(3)
2	Discuss about self purification of water bodies.	(2)
3	Enumerate the effluent characteristics of steel plants.	(2)
4	By means of a flowchart state the manufacturing process of fertilizer industry.	(3)
5	Discuss the effects of air pollutants on Human Health.	(3)
6	What do you understand by stack sampling?	(2)
7	List out the objectives of using air pollution control equipments.	(3)
8	Explain the capabilities and limitations of EIA.	(3)
9	State the various strategies of Environment Management Plan.	(2)
10	Define condensation.	(2)

PART – B (50 Marks)

11 (a) Explain in detail about effects of industrial effluents on land and human health. (6)
   (b) What are the strategies and actions implemented by environmental legislation related to hazardous wastes ? Explain. (4)

12 (a) Describe indetail the manufacturing process along with the effluent characteristics of Leather industry. (6)
   (b) Explain the wastewater characteristics and the treatment processes involved in a textile industry. (4)

13 (a) Discuss in detail about air quality standards. (5)
   (b) Explain the advantages, disadvantages and limitations of settling chamber equipment. (5)

14 Explain in detail the important meteorological parameters that influence air pollution. (10)

15 (a) Discuss the need and objectives of Environmental Impact Assessment. (5)
   (b) Enumerate the various aspects that should be included in preparation of Environment Impact statement. (5)

16 (a) Explain stable and unstable atmosphere. (4)
   (b) What are the common adsorbents used in solid form to remove SO_2, H_2S, NOx and organic solvent vapours. (6)

17 Write short notes on the following:
   (a) Principle of electrostatic precipitation (5)
   (b) Evaluation and prediction of impacts for EIA (5)

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FACULTY OF ENGINEERING

B.E. 4/4 (Civil) II – Semester (Old) Examination, May 2014

Subject: Advanced Reinforced Concrete Design
(Elective – II)

Time: 3 Hours **Max.Marks: 75**

***Note: Answer all questions from Part A. Answer any five questions from Part B.
IS 456-2000 is permitted.***

PART – A

1 How the design of curved beams differ from the design of straight beams? (3)
2 Explain the concept of shear failure is the deep beams. (3)
3 Explain briefly how a hinge is designed at base of a column of a RC portal frame. (3)
4 Draw the loading condition for the substitute frame for maximum positive and negative bending moment. (3)
5 List out the different types of substitute frames considered under ordinary condition. (2)
6 Write a short note on openings in flat slabs. (2)
7 Draw a neat sketch of a flat slab with drop and with column head showing the critical section for shear stresses. (2)
8 Under what conditions we provide raft foundation. (2)
9 Sketch the different types of raft foundations. (3)
10 List the assumptions made in equivalent frame method for analysis of flat slab. (2)

PART – B

11 A curved beam is in the form of a full continuous circle in plan with a radius of 3.5 m and is supported continuously on five supports. The beam carries a u.d.l. of 31 kN/M length, inclusive of its own weight. Determine the bending moment, twisting moment and shear force at salient locations. Also plot the BM, TM and SF diagrams for one span. (10)

12 Design a interior span of a 10 m continuous deep beam using the following data:
    Span of beam   = 10 m
    Over all depth   = 4.0 m
    Width of support   = 600 mm
    Width of beam   = 0.45 m
    u.d.l. (inclu.self wt)=   w = 200 kN/m
    use M20 concrete and Fe 415 steel. (10)

13 Design the beam of a portal frame which is subjected to the following design forces. Negative moment at junction with column M_u = 180 kN-M Positive moment at mid span M_u = 250 kN-M Shear near junction with column = V_u = 200 kN Slab thickness over the beam = 120 mm. (10)

14 The RCC portal frame hinged at its bases are of span 6.5 m, height 4.5 m and spaced at 5.5 m c/c. A typical portal carries an all inclusive udl of 21 kN/m. Design and detail an interior column and footing for the frame assuming SBC as 200 kN/m^2. Use M20 grade concrete and Fe 415 steel.

15 The substitute frame at a ty pical floor level of a multi storeyed building frame is shown below:
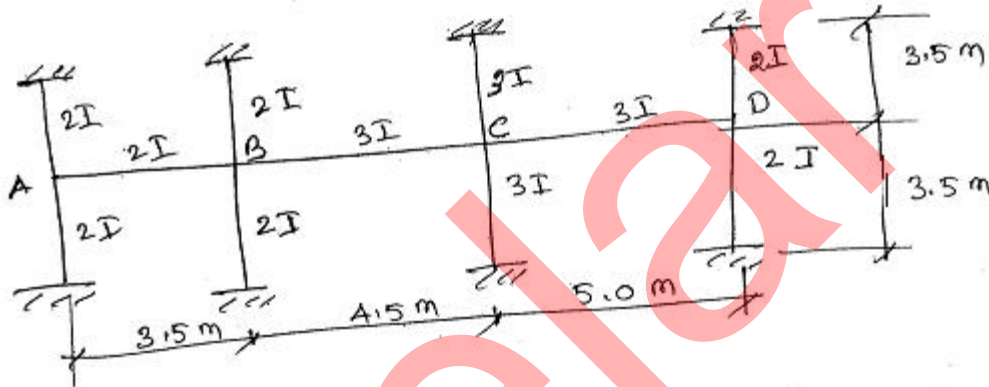
The beams are subjected to a DL = 20 kN/m and LL = 15.5 kN/m. Calculate the mid span maximum positive moment in B C and maximum support moment at C.

16 Design the typical interior panel of a flat slab floor of size 4.5 m x 4.5 m with suitable drop to support a LL of 4.3 kN/m^2. The floor is supported by columns of size 450 mm x 450 mm. Use M20 grade concrete and Fe 415 steel.

17 Design a RC raft foundation connecting the columns of a multistoreyed building the columns are arranged in square grid 16 m by 10 m with their spacing 4 m apart, the safe bearing capacity of the soil at site is 110 kN/m^2. The total service load on all the columns is 4500 kN. The columns are 400 mm by 400 mm in section. Adopt M20 grade concrete and Fe 415 steel.

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FACULTY OF ENGINEERING
B.E. 4/4 (Civil) II - Semester (New)(Main) Examination, May 2014

Subject : Advanced Reinforced Concrete Design (Elective-II)

Time : 3 Hours   **Max. Marks: 75**

Note: Answer all questions of Part - A and answer any five questions from Part - B.
PART – A (25 Marks)

1   Explain the design principles of curved beams.   (3)

2   How do you analyze the bending and torsional moments in circular beams?   (3)

3   What are the IS specifications needed for the design of deep beams?   (2)

4   Differentiate between Portal frame and Substitute frame.   (3)

5   Give the design criteria for Substitute frame.   (2)

6   Give the IS specifications for the design of flat slabs.   (3)

7   How do you check the design for flexure and shear in flat slabs?   (2)

8   What is the criteria for the design to pile foundations?   (2)

9   What is raft foundation, explain with suitable example.   (2)

10 Why column grids are provided in raft foundation?   (3)

PART – B (50 Marks)

11 Design a semicircular beam supported on 3 columns equally spaced. The centre of
    the columns are on a curve of diameter 8m. The superimposed load on the beam is
    20kN. Adopt M20 grade concrete and fe415 HYSD bars.   (10)

12 A single span deep beam has an overall depth of 4m and an effective span of 6m.
    The width of the beam in 400mm. The beam supports a uniformly distributed live
    load of 300 kN/m, over the entire span. Using M20 grade concrete and fe415 grade
    steel, design the suitable reinforcement for the beam and sketch the details.   (10)

13 A hall 50m long and 10m wide has to be covered by continuous RCC slab over
    portal frames spaced at 3m intervals. The height of the hall is 7m. Design the slab
    and one intermediate portal frame. Adopt M30 grade concrete and fe415 grade
    steel. Sketch the reinforcement details.   (10)

14 The substitute frame of a multistoried building having 3 bays has continuous beam
    ABCD with AB=4.0m, BC=2.5m, and CD=4.0m. The beams are spaced at 3m
    intervals. Thickness of floor slab = 120 mm, live load = 4 kN/m^2, floor finish = 0.6
    kN/m^2, size of the beams = 250mm x 400mm, size of the columns = 250mm x 400
    mm. Height between floors=4.0mm. Analyse the substitutes frame and estimate the
    maximum design moments in the beams and columns.   (10)

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15 Design an interior panel of a flat slab in a commercial building carrying a super imposed live load of 3.25 kN/m^2. The weight of the floor finishes on the slab may be taken as 2.15 kN/m^2. The panel is supported on 350mm dia circular columns. Drops may be provided. Size of the panel is 6m x 8m. Use M20 grade concrete and fe415 grade steel.

16 A column 500mm square carries an axial load of 1200kN and is supported on three piles driven to hard strata available at the depth of 12m. Use M20 grade concrete and fe415 grade steel. The column is placed at the centroid of the pile group and centre to centre distance of piles is restricted to 2m. Design the pile and pile cap.   (10)

17 A building consists of four column arranged in two rows and spaced 5m c/c in both the directions. The columns carry a service load of 1500 kN each. Design and detail a suitable raft foundation for the building. The soil bearing capacity of soil is 180 kN/m^2. Use M25 grade concrete and fe415 grade steel.

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FACULTY OF ENGINEERING
B.E. 4/4 (Civil) II - Semester (New)(Main) Examination, May 2014

Subject : Advanced Transportation Engineering (Elective-II)

Time : 3 Hours   **Max. Marks: 75**

Note: Answer all questions of Part - A and answer any five questions from Part-B.
PART – A (25 Marks)

1	How do you decide the type of soil stabilization?	(2)
2	Explain the concept involved in the Mehara's method of stabilization.	(3)
3	What is the major change of revised CBR method?	(2)
4	Write an expression for finding out the Group Index of soil.	(3)
5	What is skidding?	(2)
6	How do you prepare the test section for organizing the Benkelman beam test?	(3)
7	Explain Practical capacity.	(2)
8	List out different costs to be considered in the evaluation of highway projects.	(3)
9	Explain the concept of Tidel Flow.	(2)
10	Discuss about behavioural effects of noise.	(3)

PART – B (50 Marks)

11 (a) Explain Roth Futch method of stabilization with help of a neat sketch. (5)

   (b) Explain the method of soil cement mix design for carrying soil stabilization. (5)

12 (a) State the assumption made by Westerguard in the analysis of design of rigid pavement and what do you understand by Radius of relative stiffness. (5)

   (b) Compute the ESWL for the dual wheel load assembly carrying 2044kg for pavement thickness of 18cm, 22cm and 24cm given the centre to centre spacing of tyres 25cm and the distance between the walls of tyres is 10cm. (5)

13 (a) Explain the factors to be considered in finding PCU. (5)

   (b) Compare the annual costs of two types of pavements structures, (i) WBM with thin bituminous surface at total cost of Rs. 20 lakhs perkm having a life of 4years,interest at 9%, salvage value of 3 lakhs for 3 years and average maintenance of 0.4 lakhs / km and (ii) bituminous macadam and bituminous concrete surface, total cost of Rs. 30 lakhs based on a life period of 20 years interest of 8%, salvage value of 4 lakhs at the end of 20 years and average maintenance cost of Rs. 0.3 lakhs / km. (5)

14 (a) Explain the criteria to be followed in the design of filter material used in subsurface drainage system. (5)

   (b) Explain briefly about the Structural Evaluation of Pavement. (5)

15 (a) What are Parking Inventories? Explain briefly. (5)

   (b) Explain briefly about computer applications in Transportation Planning. (5)

16 (a) Explain the advantages and disadvantages of one way streets. (5)

   (b) What is Lime Fixation Point and explain its use in soil stabilization. (5)

17 Write short notes on any **four** of the following: (10)

   (a) Objectives of soil stabilization   (b) Warping stresses in Rigid pavements

   (c) Methods of accident costing   (d) Restrictions on turning moments

   (e) Air pollution due to traffic

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FACULTY OF ENGINEERING
B.E. 4/4 (Civil) II - Semester (New)(Main) Examination, May 2014

Subject : Ground Improvement Techniques (Elective-III)

Time : 3 Hours   **Max. Marks: 75**

Note: Answer all questions of Part - A and answer any five questions from Part-B.

PART – A (25 Marks)

1. What are the objectives of "blending of aggregate" in mechanical stabilization? (2)

2. In Bitumen stabilization, higher the volatile content, better is the stabilization. Answer yes or no and justify your answer. (2)

3. What is the function served by lower jet in the vibro-floatation method? (2)

4. In vertical drains technique, placement of pre-load is not necessary. Answer yes or no and justify your answer. (2)

5. Differentiate a uni-axial geogrid with a bi-axial geogrid. Name one application of each. (2)

6. Explain as to why the stabilization methods are ideal for improvement of ground in pavement applications. (3)

7. Enumerate the characteristics of a good grout material. (3)

8. The suitability number of an earth selected as back fill material in vibro-floatation method is found to be 17.585. Determine its effective size, if D_{50}=1.00mm and D_{20}=0.50mm. (3)

9. In permanent way of a railway track, the ballast is seriously intruded into the soft embankment lying below. Identify the application of geo-synthetics for improvement of the track. Suggest name of the geo-synthetic product and the function it has to serve. (3)

10. What is the significance of anchorage length in reinforced earth structures? (3)

PART – B (50 Marks)

11. (a) Explain the objectives of ground improvement with suitable examples. (5)
    (b) A hill road is proposed in seismically active Himalayan region. Enumerate the geotechnical challenges involved in this project. Discuss the need for ground improvement in this case. Identify various options for improvement of this ground and suggest the ideal ground improvement technique. (5)

12. (a) Compare mechanical stabilization with cementing methods of stabilization including the principle on which each method is based, merits and demerits and suitability of each. (5)
    (b) Among all the ground improvement techniques, what is the uniqueness of grouting. Explain the applications of grouting with suitable examples. (5)

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13 (a) Explain the mechanism of in-situ densification of cohesionless soils in dry, partially saturated and fully saturated states, using vibration methods. (5)
    (b) Describe "Vibra-floatation" technique including its merits and demerits. (5)

14 (a) Discuss how dewatering helps in ground improvement and explain the "Well point system" of dewatering in detail including its merits and demerits, suitability. (5)
    (b) Explain the "preloading" technique and suggest its applications. (5)

15 (a) Explain the function served by vertical drains. (3)
    (b) To accelerate the consolidation process of a 10m thick fully saturated compressible clay, sand drains are provided and a preloading in the form of a 30 high embankment is constructed at a unit weight of 21 kN/cum. After a certain period of effective loading, the overall degree of consolidation was found to be 89.20% and that due to radial drainage was 78.40%. Determine
        (i)   Magnitude of settlement corresponding of U = 89.20%, if coefficient of volume compressibility is 3.2×10^{-4} sqm / kN; (7)
        (ii) Time corresponding to U=89.20%, if C_v = 4.50 sqm/year and single drainage is present.

16 (a) Write a detailed note on separation function served by geo-textile including related applications. (5)
    (b) Explain the concept of reinforced earth. Describe the reinforced soil wall with the help of a neat sketch. (5)

17 Write short notes on any two of the following: (10)
    (a) Compaction piles
    (b) Stone columns
    (c) Lime stabilization

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FACULTY OF ENGINEERING
B.E. 4/4 (Civil) II – Semester (Old) Examination, May 2014

Subject : Advanced Transportation Engineering (Elective – III)

Time : 3 hours   **Max. Marks : 75**

Note: Answer all questions from Part-A. Answer any FIVE questions from Part-B.
PART – A (25 Marks)

1	What are the basic principles of soil stabilization?	3
2	When do you select triangular chart method for soil stabilization?	2
3	Find out the group index value for the following data of soil material passing through 0.074 mm sieve is = 45%, Liquid limit = 55%, Plastic limit = 43%	3
4	Discuss about the relationship between tyre pressure and contact pressure.	2
5	Find out weighted average of coefficient of runoff used in estimating surface drainage of a highway.	3

Bitumen surface width = 7m; Shoulder and adjoining land width = 8.5m
Width of reserve land on the other side of drain from which rain water flows to the drain = 20m ; Length of drain parallel to road = 450m; The run off coefficients of pavement, shoulders and reserve land are 0.6, 0.2 and 0.3 respectively.

6	Define level of service.	2
7	What are discounting cash flow methods used in highway project evaluation?	3
8	Explain 'Human capital' approach of accident costing.	2
9	Write short notes on restrictions of right turn moments at junctions.	3
10	Define the term 'Noise'.	2

PART – B (50 Marks)

11	a)	Explain briefly about the design of soil cement stabilization.	5
	b)	Explain briefly about factors affecting soil bitumen stabilization.	5
12	a)	Discuss about the revised CBR method of designing flexible pavement.	5
	b)	What is the critical combination of stresses that are to be considered in the design of rigid pavement?	5
13	a)	What is overlay? List out various categories of overlay	4
	b)	Explain the measures to be taken for the control of capillarity rise of ground water in highway drainage system.	6
14	a)	Explain the factors influencing level of service of highways.	5
	b)	Explain the objectives of carrying evaluation of highway projects.	5
15	a)	Discuss about the major problems related to the traffic in your city.	5
	b)	Explain the TMS techniques adopted in traffic management.	5
16	a)	Discuss about skid resistance on highways.	5
	b)	What are the different types of parking facilities? Explain briefly.	5
17		Write short notes on any **two** of the following :	10
	a)	Computer applications in traffic engineering	
	b)	Rothfutch method of soil stabilization c) PCU	

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