



# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)  
Dundigal, Hyderabad-500043

## CIVIL ENGINEERING

### TUTORIAL QUESTION BANK

<b>Course Title</b>	<b>STRUCTURAL HEALTH MONITORING</b>				
<b>Course Code</b>	BSTB07				
<b>Programme</b>	M.Tech				
<b>Semester</b>	I	STE			
<b>Course Type</b>	Professional Elective.				
<b>Regulation</b>	IARE - R18				
<b>Course Structure</b>	<b>Theory</b>			<b>Practical</b>	
	<b>Lectures</b>	<b>Tutorials</b>	<b>Credits</b>	<b>Laboratory</b>	<b>Credits</b>
	3	-	3	-	-
<b>Chief Coordinator</b>	Mr. N. VenkatRao Associate Professor.				
<b>Course Faculty</b>	Mr. N. VenkatRao, Associate Professor.				

#### COURSE OBJECTIVES:

<b>The course should enable the students to:</b>	
I	Diagnosis the distress in the structure understanding the causes and factors
II	Assess the health of structure using static field methods
III	Assess the health of structure using dynamic field tests.
IV	Suggest repairs and rehabilitation measures of the structure

#### COURSE OUTCOMES (COs):

CO 1	Know the causes of Distress in structures, factors effecting structural health, need of regular maintenance of structures.
CO 2	Understand the concept of structural health monitoring and various methods applied for monitoring of structures and structural safety
CO 3	Understand the importance of structural audit and Assessment of Health Structure, Collapse and Investigation, Investigation Management, SHM Procedures
CO 4	Know The Importance of Static field testing, Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement
CO 5	Understand the Dynamic Field testing, stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition systems, Remote Structural Health Monitoring. Introduction to Repairs and Rehabilitations of Structures impedance (EMI) technique, Adaptations of EMI technique

## COURSE LEARNING OUTCOMES:

BSTB07.01	Understand deterioration and distress in structures.
BSTB07.02	Identify the condition of structures.
BSTB07.03	Identify the type of deterioration and method of correction.
BSTB07.04	Understand the general causes of distress.
BSTB07.05	Evaluate causes and prevention methods for structural health monitoring.
BSTB07.06	Understand the concepts for structural health monitoring.
BSTB07.07	Understand various measures in structural health monitoring.
BSTB07.08	Understand the safety of structures in structural health monitoring.
BSTB07.09	Identify the importance of structural audit.
BSTB07.10	Analyse structural health monitoring.
BSTB07.11	Analyse inspection and testing of concrete.
BSTB07.12	Identify symptoms and diagnosis of distress.
BSTB07.13	Understand the damage assessment.
BSTB07.14	Understand the procedure of structural health monitoring.
BSTB07.15	Importance of Investigation Management.
BSTB07.16	Understand Simulation and Loading Methods in static field.
BSTB07.17	Understand the sensor systems in structural health monitoring.
BSTB07.18	Recognize the importance of Static Response Measurement.
BSTB07.19	Understand health monitoring of structures by Dynamic Response Method.
BSTB07.20	Analyse Data Acquisition Systems in dynamic field testing methods.
BSTB07.21	Understand building instrumentation.
BSTB07.22	Recognize the behaviour of sensors.
BSTB07.23	Understand piezo- electric materials and other smart materials in structural health monitoring.

## TUTORIAL QUESTION BANK

S. No	QUESTIONS	Blooms Taxonomy Level	Course Outcomes	Course Learning Outcomes
<b>UNIT I</b>				
<b>STRUCTURAL HEALTH</b>				
<b>Part - A (Short Answer Questions)</b>				
1	State the factors affecting Health of Structures	Understand	CO 1	BSTB07.01
2	Write short notes on division of maintenance.	Remember	CO 1	BSTB07.01
3	Define distress?	Remember	CO 1	BSTB07.02
4	define repair in a structure	Remember	CO 1	BSTB07.02
5	Name different types of distress?	Remember	CO 1	BSTB07.03
6	What is deterioration in a structure?	Remember	CO 1	BSTB07.01
7	What are the factors responsible for the deterioration of paints?	Remember	CO 1	BSTB07.01
8	Write a short note on cracking	Understand	CO 1	BSTB07.03
9	Write a short note on settlement	Understand	CO 1	BSTB07.01
10	What is spalling in concrete structures ?	Remember	CO 1	BSTB07.02
11	Name the factors responsible for causes of damages in fresh state.	Remember	CO 1	BSTB07.01
12	What are the various causes of damages after hardening.	Analyze	CO 1	BSTB07.04
13	Identify physical causes of damages after hardening.	Remember	CO 1	BSTB07.04
14	Write a short note on chemical causes of damages after hardening	Remember	CO 1	BSTB07.05
15	Write a short note on thermal causes of damages after hardening	Remember	CO 1	BSTB07.03
16	What setting shrinkage in concrete?	Understand	CO 1	BSTB07.04
17	What is aggregate shrinkage?	Understand	CO 1	BSTB07.01
18	Describe temperature variation in concrete.	Analyze	CO 1	BSTB07.02

19	Write a short note on alkali-aggregate reaction.	Remember	CO 1	BSTB07.03
20	Write a short note on creep	Remember	CO 1	BSTB07.01
<b>Part - B (Long Answer Questions)</b>				
1	What do you mean by deterioration? Explain the mechanism of deterioration in concrete structures?	Remember	CO 1	BSTB07.01
2	Discuss in detail the various factors responsible for deterioration.	Understand	CO 1	BSTB07.01
3	Discuss in detail various construction stage defects & their preventive measures?	Understand	CO 1	BSTB07.01
4	What are the various pre-construction stage damages & how can it be rectified?	Analyze	CO 1	BSTB07.03
5	Explain the mechanism of various causes of deterioration in post-construction stage?	Understand	CO 1	BSTB07.02
6	Explain preventive maintenance of structures? Explain them in detail	Understand	CO 1	BSTB07.02
7	What are settlement cracks? What are the factors affecting the settlement cracks?	Remember	CO 1	BSTB07.03
8	Write the different reasons for development of cracks due to errors in design and detailing. Give preventive measures.	Remember	CO 1	BSTB07.03
9	Name various chemical attacks in concrete & explain their mechanism in detail. Give the preventive measures?	Remember	CO 1	BSTB07.04
10	Explain the need of maintenance in structural health monitoring.	Analyze	CO 1	
11	Explain various types of inspection and maintenance methods in detail with a flow chart	Understand	CO 1	BSTB07.01
12	What is carbonation, factors effecting carbonation? Explain its mechanism in details, suggest suitable remedial measures.	Understand	CO 1	BSTB07.01
13	What is distress? Give its classification.	Remember	CO 1	BSTB07.01
14	Explain in detail various causes of damage in fresh state? Suggest the suitable remedial measures?	Understand	CO 1	BSTB07.02
15	What are the various pre-construction stage damages & how can it be rectified?	Analyze	CO 1	BSTB07.03
16	explain in detail regarding mechanism of accidental overloads in concrete and their remedial measures	Understand	CO 1	BSTB07.01
17	Discuss in detail the cracking of hardened concrete.	Understand	CO 1	BSTB07.02
18	Explain in detail regarding mechanism of temperature variation in concrete and their remedial measures	Remember	CO 1	BSTB07.03
<b>Part – C (Problem Solving and Critical Thinking)</b>				
1	What are the factors affecting structural health? Explain them in detail.	Understand	CO 1	BSTB07.02
2	What is distress? Give its classification.	Understand	CO 1	BSTB07.02
3	Write short notes on division of maintenance.	Understand	CO 1	BSTB07.02
4	What are the various categories of deterioration?	Analyze	CO 1	BSTB07.01
5	Explain in detail regarding mechanism of temperature variation in concrete and their remedial measures	Understand	CO 1	BSTB07.01
6	Explain in detail regarding mechanism of early thermal cracking in fresh concrete and their remedial measures	Analyze	CO 1	BSTB07.04
7	Explain in detail regarding mechanism of accidental overloads in concrete and their remedial measures	Understand	CO 1	BSTB07.03
8	Explain in detail regarding mechanism of creep in concrete and their remedial measures	Analyze	CO 1	BSTB07.02
9	What are various types of shrinkage? Explain them in detail.	Understand	CO 1	BSTB07.03
10	What is creep in concrete? State its effects in detail.	Understand	CO 1	BSTB07.01
11	Write a short note on chemical attack on concrete structures	Understand	CO 1	BSTB07.02

12	Write a short note on chemical attack aggregate alkali reaction	Understand	CO 1	BSTB07.04
13	Write a short note on cement carbonation	Understand	CO 1	BSTB07.03
14	What are the various causes of damage?	Understand	CO 1	BSTB07.03
<b>UNIT II</b>				
<b>STRUCTURAL HEALTH MONITORING</b>				
<b>Part - A (Short Answer Questions)</b>				
1	Define the concept of health monitoring of structures.	Understand	CO 2	BSTB07.05
2	What are the basics of structural health monitoring	Remember	CO 2	BSTB07.05
3	What is importance of passivating film in RCC members?	Remember	CO 2	BSTB07.05
4	What are the system components of structural health monitoring	Remember	CO 2	BSTB07.05
5	What is delamination?	Remember	CO 2	BSTB07.06
6	Write the effect of cast in chlorides on corrosion	Remember	CO 2	BSTB07.05
7	What is carbonation?	Understand	CO 2	BSTB07.06
8	What happens to concrete in fire?	Remember	CO 2	BSTB07.06
9	Write about changes observed in concrete in fire	Remember	CO 2	BSTB07.06
10	Name few laboratory tests for fire safety	Remember	CO 2	BSTB07.06
11	Name few corrosion prevention techniques?	Understand	CO 2	BSTB07.06
12	What is fire rating?	Remember	CO 2	BSTB07.07
13	What is desiccation?	Remember	CO 2	BSTB07.08
14	how does the strength of concrete vary due to rise in temperature	Understand	CO 2	BSTB07.08
15	how does the strength of steel vary due to rise in temperature	Remember	CO 2	BSTB07.08
16	Behaviour of masonry under fire?	Remember	CO 2	BSTB07.08
17	Name various stages of repair of fire damaged elements	Remember	CO 2	BSTB07.07
<b>Part - B (Long Answer Questions)</b>				
1	What are the various methods of locating in structural members? Discuss any one method in detail.	Remember	CO 2	BSTB07.05
2	Explain the working system of components of structural health monitoring in detail.	Remember	CO 2	BSTB07.06
3	What are the various steps involved in structural health monitoring? Explain them in detail	Remember	CO 2	BSTB07.05
4	Explain in detail mechanism of carbonation induced corrosion, suggest suitable remedial measures?	Understand	CO 2	BSTB07.06
5	What are the objectives of structural health monitoring		CO 2	BSTB07.07
6	Explain in detail the behaviour of concrete at various temperatures when it is subjected to fire	Remember	CO 2	BSTB07.07
7	What is meant by cementitious spray fire proofing?	Understand	CO 2	BSTB07.08
8	write in detail about the factors influencing the cracking and spalling and mention regarding C/D ratio	Understand	CO 2	BSTB07.08
9	Describe the method of protecting building against fire	Remember	CO 2	BSTB07.05
10	Explain the phenomena of desiccation in structures.	Understand	CO 2	BSTB07.06
11	Explain fire rating of structure?	Understand	CO 2	BSTB07.05
12	Explain behaviour of steel under fire? What is the effect of yield strength of steel with increase in temperature?	Understand	CO 2	BSTB07.05
13	Explain the effect of steel manufacturing process, type of connections on the behaviour of steel under fire?	Analyze	CO 2	BSTB07.05
14	Explain in the detail the assessment procedure to be followed in concrete structures subjected to fire?	Understand	CO 2	BSTB07.06
15	Explain in detail differential thermal analysis (DTA) and thermo gravity analysis along with its merits & demerits?	Understand	CO 2	BSTB07.05

16	Explain in detail repair of fire damaged elements?	Understand	CO 2	BSTB07.05
17	Explain the procedure for fire rating of structure using ASTM E 119?	Analyze	CO 2	BSTB07.05
18	What is the effect of thickness & cover requirements on the fire rating of the structure or vice versa?	Understand	CO 2	BSTB07.05
19	Explain the Effect of desiccation of concrete on the deterioration of concrete	Understand	CO 2	BSTB07.07
20	Write different preventive measures of self-desiccation of concrete	Analyze	CO 2	BSTB07.07
<b>Part – C (Problem Solving and Critical Thinking)</b>				
1	State various Alteration methods in Structural Safety. Explain in detail	Understand	CO 2	BSTB07.05
2	Explain the process of Structural health monitoring in step by step process in detail	Understand	CO 2	BSTB07.06
3	Write about preventive measures that ensure good protection for new structures.	Understand	CO 2	BSTB07.05
4	Explain the cathodic reaction in detailed.	Understand	CO 2	BSTB07.05
5	write about the chloride penetration and factors on which the it depends	Analyze	CO 2	BSTB07.06
6	write in detail about the factors influencing the cracking and spalling and mention regarding C/D ratio	Understand	CO 2	BSTB07.07
7	Explain the method of repairing corroded steel in R.C structure.	Analyze	CO 2	BSTB07.07
8	Describe the method of protecting building against fire.	Understand	CO 2	BSTB07.07
9	On what basis is a structure designed to withstand fire.	Understand	CO 2	BSTB07.08
10	Give description about fire damaged structures.	Understand	CO 2	BSTB07.08
11	write about the embedded metal corrosion and tolerable crack widths to avoid the rebar corrosion	Understand	CO 2	BSTB07.08
12	Describe the concrete encasement method of protecting building against fire.	Analyze	CO 2	BSTB07.08
<b>UNIT 3</b>				
<b>STRUCTURAL AUDIT AND STATIC FIELD TESTING</b>				
<b>Part – A (Short Answer Questions)</b>				
1	Explain the need of evaluation of structures.	Understand	CO 3	BSTB07.09
2	Briefly describe of preliminary investigation & Detailed investigation in structural auditing.	Remember	CO 3	BSTB07.09
3	Classify the damage based on preliminary investigation	Remember	CO 3	BSTB07.09
4	What is structural audit?	Remember	CO 3	BSTB07.10
5	What is quality control of in structures	Understand	CO 3	BSTB07.10
6	Define maintenance of structures	Remember	CO 3	BSTB07.10
7	Write names of different NDT tests for strength estimation of concrete	Remember	CO 3	BSTB07.11
8	Write about rebound hammer test	Remember	CO 3	BSTB07.11
9	Write names of different NDT tests for assessing corrosion potential of concrete	Remember	CO 3	BSTB07.12
10	Write about half-cell potential method	Remember	CO 3	BSTB07.12
11	What is static based structural health monitoring.	Remember	CO 3	BSTB07.13
12	Name different Types of Static Tests in static structural health monitoring.	Remember	CO 3	BSTB07.13
13	What are the pros and cons of static structural health monitoring system	Remember	CO 3	BSTB07.14
14	What are the different Simulation in static structural health monitoring.	Remember	CO 3	BSTB07.15
15	Explain the Loading Methods in static structural health monitoring system	Remember	CO 3	BSTB07.16
16	Define sensor systems in static structural health monitoring.	Remember	CO 3	BSTB07.14

17	List out the hardware tools required in static structural health monitoring.		CO 3	BSTB07.16
18	Define the term Static Response Measurement	Remember	CO 3	BSTB07.16
<b>Part - B (Long Answer Questions)</b>				
1	Explain the standard procedure followed for structural auditing.	Remember	CO 3	BSTB07.09
2	What are the various methods employed in structural auditing.	Remember	CO 3	BSTB07.09
3	Describe the occurrence of distress Due to Pre-construction stage, Construction stage and Post construction stage	Analyze	CO 3	BSTB07.09
4	Write various categories of inspection and maintenance involved in structural health monitoring?	Analyze	CO 3	BSTB07.09
5	Give a brief description about the factors that influence the investigation plan	Remember	CO 3	BSTB07.10
6	Describe Electrical Resistivity Method and its influencing factors	Remember	CO 3	BSTB07.10
7	Explain petrographic analysis and its application in civil engineering structures.	Remember	CO 3	BSTB07.10
8	Briefly describe various voids detection tests along with their merits and demerits	Remember	CO 3	BSTB07.10
9	Explain commonly used NDT tests and write its advantages over other tests	Analyze	CO 3	BSTB07.11
10	Explain Initial Surface absorption test & brief its demerits	Remember	CO 3	BSTB07.12
11	Explain the different Types of Static Tests in detail.	Understand	CO 3	BSTB07.09
12	Discuss Simulation and Loading Methods in static structural health monitoring.	Understand	CO 3	BSTB07.09
13	Explain the role of sensor systems in static structural health monitoring.	Remember	CO 3	BSTB07.09
14	What are the functions of hardware tools in static structural health monitoring?	Understand	CO 3	BSTB07.10
15	Explain about Static Response Measurement	Remember	CO 3	BSTB07.10
16	Explain long-Term static structural health monitoring?	Understand	CO 3	BSTB07.10
17	What is seismic structural health monitoring?	Understand	CO 3	BSTB07.11
18	Write short notes on intelligent structural health monitoring?	Understand	CO 3	BSTB07.11
19	List out the applications of structural health monitoring in post-earth quake controls.	Remember	CO 3	BSTB07.12
20	What are smart material and explain their applications in structural health monitoring	Remember	CO 3	BSTB07.12
<b>Part – C (Problem Solving and Critical Thinking)</b>				
1	Explain the need and importance of quality control and quality audit in structures.	Understand	CO 3	BSTB07.09
2	What are the aims of quality control system? Explain in detail.	Analyze	CO 3	BSTB07.09
3	What are the major quality controlling factors in concrete?	Understand	CO 3	BSTB07.09
4	Give Short notes on Inspection of structures.	Analyze	CO 3	BSTB07.10
5	Briefly describe of Recommendation for retrofit work.	Understand	CO 3	BSTB07.10
6	What is the effect of aluminium in hydration process	Understand	CO 3	BSTB07.10
7	Influence of silicates on hydration	Understand	CO 3	BSTB07.11
8	Examine the role of chemical compounds on the durability of concrete	Analyze	CO 3	BSTB07.11
9	What is the effect of temperature on the strength of concrete examined critically?	Understand	CO 3	BSTB07.12

10	Explain various methods of crack detection	Analyze	CO 3	BSTB07.12
<b>UNIT 4</b>				
<b>DYNAMIC FIELD TESTING</b>				
<b>Part – A (Short Answer Questions)</b>				
1	Name the types of Dynamic Field Test	Understand	CO 4	BSTB07.17
2	What is vibration based structural health monitoring.	Remember	CO 4	BSTB07.18
3	State the different forms of Dynamic Response Methods	Remember	CO 4	BSTB07.18
4	What is Dynamic Response Method	Remember	CO 4	BSTB07.19
5	Name different types of sensors used in structural health monitoring	Understand	CO 4	BSTB07.20
6	Define epoxy resins.	Remember	CO 4	BSTB07.20
7	Write short notes on member replacement.	Remember	CO 4	BSTB07.20
8	Define overlays. What are the materials generally used for overlays?	Understand	CO 4	BSTB07.21
9	What are the barriers in structural health monitoring	Remember	CO 4	BSTB07.22
<b>Part - B (Long Answer Questions)</b>				
1	Explain the process of Repairs and Rehabilitations of Structures in detail	Remember	CO 4	BSTB07.21
2	Discuss how piezo– electric materials are used in structural health monitoring.	Analyze	CO 4	BSTB07.21
3	What are the various model based techniques in dynamic structural health monitoring.	Remember	CO 4	BSTB07.22
4	Explain the functioning of smart materials used in structural health monitoring.	Remember	CO 4	BSTB07.22
5	Discuss the role of Hardware in Remote Data Acquisition Systems	Remember	CO 4	BSTB07.23
6	What are the pros and cons of model based techniques in vibration based structural health monitoring.	Remember	CO 4	BSTB07.23
7	Define and explain in detail about electro–mechanical impedance (EMI) technique	Analyze	CO 4	BSTB07.22
8	Write a short notes on data based techniques in vibration based structural health monitoring.	Remember	CO 4	BSTB07.23
9	Explain the application and Adaptations of EMI technique in structural health monitoring.	Remember	CO 4	BSTB07.23
10	What are the structural health monitoring challenges in present scenario	Analyze	CO 4	BSTB07.23
<b>UNIT-V</b>				
<b>INTRODUCTION TO REPAIRS AND REHABILITATIONS OF STRUCTURES</b>				
<b>Part – A (Short Answer Questions)</b>				
1	Enumerate the various cracks repairs techniques and other repair techniques for structures.	Understand	CO 5	BSTB07.17
2	How bridge Decks are repaired? Discuss briefly.	Remember	CO 5	BSTB07.18
3	What are underwater repairs? Mention its special features.	Remember	CO 5	BSTB07.18
4	What are the various types of surface coatings?	Remember	CO 5	BSTB07.19
5	Discuss in brief the methods of grout injection.	Understand	CO 5	BSTB07.20
6	What are piezo– electric materials.	Remember	CO 5	BSTB07.20
7	Define Remote Structural Health Monitoring	Remember	CO 5	BSTB07.20
8	Explain the procedure for Adaptations of EMI technique.	Understand	CO 5	BSTB07.21
9	State electro–mechanical impedance (EMI) technique	Understand	CO 5	BSTB07.21
10	How erosion control can be done.	Understand	CO 5	BSTB07.21
11	What is slope protection?	Remember	CO 5	BSTB07.22
12	What are the smart materials used in structural engineering?	Remember	CO 5	BSTB07.21
13	What are the sensors in structural health monitoring?	Remember	CO 5	BSTB07.21

<b>Part - B (Long Answer Questions)</b>				
1	Explain the process of Repairs and Rehabilitations of Structures in detail	Understand	CO 5	BSTB07.21
2	Discuss how piezo– electric materials are used in structural health monitoring.	Remember	CO 5	BSTB07.21
3	What are the various model based techniques in dynamic structural health monitoring.	Remember	CO 5	BSTB07.22
4	Explain the functioning of smart materials used in structural health monitoring.	Understand	CO 5	BSTB07.22
5	Discuss the role of Hardware in Remote Data Acquisition Systems	Remember	CO 5	BSTB07.23
6	What are the pros and cons of model based techniques in vibration based structural health monitoring.	Analyze	CO 5	BSTB07.23
7	Define and explain in detail about electro–mechanical impedance (EMI) technique	Understand	CO 5	BSTB07.22
8	Write a short notes on data based techniques in vibration based structural health monitoring.	Remember	CO 5	BSTB07.23
9	Explain the application and Adaptations of EMI technique in structural health monitoring.	Analyze	CO 5	BSTB07.23
10	What are the structural health monitoring challenges in present scenario	Remember	CO 5	BSTB07.23
11	Explain the process of guniting in detail with figure.	Remember	CO 5	BSTB07.21
12	Discuss the method of underpinning in detail.	Remember	CO 5	BSTB07.22
13	Discuss the various types of blanket repair techniques.	Remember	CO 5	BSTB07.22
14	Enumerate the different methods available for repairs of concrete works. Discuss the any one in detail.	Analyze	CO 5	BSTB07.23

**Prepared by:**

Mr. N.VenkatRao, Assistant Professor, CE

**HOD, CE**