# COURSE NAME: BUILDING MAINTENANCE & SERVICES

**COURSE CODE: 5011** | **QID-1503240232** | **REV. 2015**

| Q. No. | Scoring Indicators | Split Score | Sub Total | Total Score |
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| | **PART -A** | | | **10** |
| I.1. | The maintenance done after a failure of operation is classified as Remedial maintenance | | 2 | |
| I.2. | Obsolescence refers to the process of becoming outdated or no longer useful, typically due to advances in technology, changes in consumer preferences, or the introduction of newer, more efficient products or methods | | 2 | |
| I.3. | The requirements of good flooring are non-slipperiness, evenness, resistance to abrasion, being free of dampness, hygiene and easiness of cleaning, durability, being economical | Any 2 2x1 | 2 | |
| I.4. | Plug and Socket is generally used for drawing supply to an electric gadget or equipment. Usually, they are rated at 5A and 16 A | | 2 | |
| I.5. | Conservation includes the preservative measures taken to keep historical structures and those of world heritage in their original form and performance. Conservation will prevent the deterioration of the building or heritage site. During conservation, the main objective is to maintain its original form. No modifications or alterations will be made to the structure. | | 2 | |
| | **PART- B** | | | **30** |
| II.1 | 1. Durability is important from an economic aspect.<br>2.Safety and serviceability are closely related to durability.<br>3.Durability is the yard stick for reliability and availability.<br>4. Durability enhances the useful life period or life cycle of the structure.<br>5.For durable structures, the maintenance requirement is minimum.<br>6. Durability reduces the maintenance cost.<br>7.It extends the difficulties in demolishing and replacement/ reconstruction cost.<br>8.Sinking fund instalment is low for durable structures.<br>9.Life cycle cost is minimum for durable structures. | Any 6 6x1 | 6 | |

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| II.2 | The usage of structures is also detrimental to its durability. Structures which are frequently used are subject to aggressive wear and tear (For example, the stairways of public buildings). The structures subjected to dynamic loading experiences cyclic reversal of stresses, which causes cracks and may be subject to fatigue failure. The structures which are subjected to overloading may experience excessive deflection cracks and creep in concrete. Cracks in concrete are highly detrimental to its durability. The corrosive agents percolate through this micro and macro cracks, deepening the aggressiveness of deterioration and reducing the durability of structures. | | 6 | |
| II.3 | The common defects observed masonry are structural and non-structural cracks. This is mainly due to foundation failure and unequal settlement, shrinkage cracks, thermal stress, shocks and vibrations. The other common defects are out of plumb construction, improper bond, efflorescence, continuous vertical joint, unequal load distribution, unequal expansions, problems due to lateral forces and tensile stresses etc. | | 6 | |
| II.4 | 1. Non uniformity in rise and tread.<br>2. Excessive rise and insufficient tread.<br>3. Insufficient width of the stair.<br>4. Improper slope of stair.<br>5. Insufficient headroom.<br>6. Nonstandard height of the hand rails and large gaps between balusters.<br>7. Improper lighting and ventilation<br>8. Glare<br>9. Inconvenient geometry<br>10. Improper location | Any six<br>6x1 | 6 | |
| II.5 | Prepare a proper design and plumbing layout plan with minimum distance from OH tank. Ensure required head and capacity for the storage tank to attain minimum tap pressure. Also avoid excessive tap pressure. Avoid sharp bends, and sudden enlargement and reduction in the size of the pipes to avoid loss of head. While selecting pipes, check internal roughness to ensure minimum loss of head due friction. Check the quality of pipe material to ensure potable grade and lesser chances of corrosion. Leakages should be checked by conducting pressure test. | | 6 | |
| II.6 | The commonly adopted retrofitting works are<br>1) Strengthening or rebuilding the foundation<br>2) Structural strengthening of the superstructure and roof<br>3) Reconstruction of floors | Any 6<br>6x1 | 6 | |

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| | 4) Renovating building fabric<br>5) Fitting or replacing doors and windows<br>6) Re-plastering<br>7) Repairs to concrete structures such as grouting, guniting, etc.<br>8) Repair and re-building of monumental heritage works with special kind of finishes, wall painting etc.<br>9) Elevating or relocating buildings in unavoidable situations<br>10) Preservation works for preventing further deterioration | | | |
| II. 7 | **Shoring** is the temporary support given to weak structures to prevent further damage or failure. Shoring is also provided to structures during retrofitting operations.<br>**Underpinning** is the method of supporting the superstructure in the repair or replacement of any sub-structure, like the foundation, doors and windows. Generally, the support is made by inserting a steel channel section or -section from either side of the wall. In the case of the foundation, an access pit will be driven to reach the foundation from the outside, along with digging inside. | 2x3 | 6 | |
| | PART -C | | | 60 |
| III. a | 1. Type of construction<br>2. Type of occupancy<br>3. Materials used for construction<br>4. Permeability of the structure<br>5. Various chemicals present in the locality<br>6. Maintenance carried out<br>7. Usage of the structure<br>8. Quality and workmanship<br>9. Extent of exposure<br>10. Environmental factors such as air, sun, frost, and biological agents such as Vegetation and insects<br>11. Natural calamities<br>12. Human attacks like war and terrorist attack | Any 8<br>8x1 | 8 | |
| III. b | The various factors that are to be considered while planning a maintenance operation are,<br>1. Properly assess the maintenance need<br>2. List and schedule maintenance work<br>3. Prepare a realistic and accurate estimate for maintenance<br>4. Prepare an operation plan<br>5. List the hurdles in maintenance operation and find remedial measures | Any 7<br>7x1 | 7 | |

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| | 6. Form a strategic team for important maintenance work and fix their responsibilities<br>7. Formulate safety measures and implement them properly<br>8. Study the existing documentation and document the complete maintenance plan<br>9. Ensure quality control<br>10. Arrange alternate arrangements in the event of complete or partial shutdown<br>11. Inform the public if necessary<br>12. Inform the appropriate authority and get the concurrence or sanctions before starting maintenance operation | | | |
| IV. a | Classification of maintenance:<br>1) Routine maintenance<br>2) Preventive maintenance<br>3)Remedial maintenance or break down maintenance<br>4) Special maintenance.<br>**Routine maintenance:** This is the maintenance done to the structure, machinery or installation at regular intervals of time. The intervals may vary for different tasks, and may be daily, weekly, fortnightly, monthly, quarterly, half yearly, yearly etc. Cleaning of rooms may be done on a daily basis; the routine rail track maintenance or machinery maintenance may be done once in a week and the painting works of buildings may be done yearly or biennially. Pre-monsoon maintenance such as cleaning gutters; terrace etc. done before monsoon is also a part of routine maintenance done annually.<br>**Preventive maintenance:** This is a type of maintenance done to prevent a failure. E.g. Oiling and lubrication of machineries, PCR (petty construction and repairing) works of buildings (This includes easing doors and windows, replacing glass panes, painting works, repairing of plastering) etc.<br>**Remedial maintenance**: This is also known as break down maintenance. This type of maintenance is done in the event of a failure or break down. Replacing of a non-working electric bulb, repair of structural crack, repairs of the foundation etc. fall under this category.<br>**Special maintenance**: This kind of maintenance is done for a special purpose, to achieve more functionality for the building. This includes renovation of the floor, ceiling or roof, changing or constructing partition walls, providing façades or | 4x.5=2<br><br>Any 3<br>3x2=6 | 8 | |

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| | changing elevation, rewiring of electrical circuits etc. Machinery overhauling and engine works also belong to this category. | | | |
| IV. b | • Importance of the structure<br>• Purpose of the structure<br>• Materials used for construction<br>• Cost incurred in construction<br>• Difficulties and cost of re-construction<br>• Obsolescence factor<br>• Hazards in the event of poor durability<br>• Safety aspects of the structure<br>• External factors | Any 7<br>7x1 | 7 | |
| V. a | The common causes for defects and failures noticed in foundation are improper compaction of sub-soil, unequal sinking, lowering of the bearing capacity of sub-soil due to water logging, over loading or differential loading of structure, deterioration of foundation material, sub-soil erosion, liquefaction of sub soil, sand boiling, seismic actions, shocks and vibrations in neighbourhood due to pile driving etc., roots of trees penetrating into foundation, consolidation settlement, insufficient cover, sulphate and chloride attack in the case of RCC footing, bad workmanship, and improper bonds in masonry foundation. These causes manifest as sinking and unequal settlement, causing cracks in the foundation and the superstructure. In the worst case, the whole structure may collapse. | | 8 | |
| V. b | The commonly adopted remedial measures include the use of well-seasoned hard wood like Irul wood, treating the wood with anti-termite coating, providing a minimum slope of rise equal to 1/3 span, conducting a pre-monsoon check-up, re-thatching periodically by replacing decayed wooden members, providing eve boards to protect the eve end of rafter etc. In order to prevent risk of fire, the preventive measures include avoiding situations that might lead to a fire, coating the wood with fire retarding material, and providing an additional sacrificial section for wooden members. Anti-fungal treatment using copper sulphate, applying anti-termite treatment using crude oil, diesel etc. will help improve durability | | 7 | |
| VI. a | Making concrete impermeable and providing adequate cover are means to check corrosion of reinforcement. Epoxy coating on reinforcement also a control measure to contain corrosion, The corrosion of external steel structures like steel truss can be controlled by cathodic protection and | | 8 | |

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| | coating with anti-corrosive paint. In the case of galvanised sections, the corrosion begins where the galvanising is lost due to welding, drilling etc. Hence special painting is to be done where hot work or mechanical grinding is done on GI sections. In the case of tubular sections, it is preferable to close the free end to prevent entry of air and moisture, as both trigger corrosion. Conventionally, steel structures are painted with aluminium paint, which has a low viscosity and shinning appearance. It can penetrate into the minute crevices on the steel surface. Nowadays, latex based anti-corrosive paints are also available, which is elastic and prevents cracking. Removal of rust, oil and grease from metal surface is an important surface preparation before applying paint. Emery paper, blow lamp or sand blasting technique can be used to remove old paint from the steel surface. | | | |
| VI. b | Cracks can be measured and monitored by various methods. Insertion of the feeler gauge blade is one direct method to measure the width of the crack. Scales with thickness marked on it, ultra sound electronic scanning devices etc. can also be used for this purpose. Larger cracks can be measured using mechanical gauges like vernier callipers. The propagation or further widening of a crack can be checked by accurately measuring the distance between a pair of parallel lines on either side of the crack periodically. To understand minor developments of cracks, a glass strip can be firmly fixed across it, bridging the crack using strong-bonding glues. Any minute developments in the crack will cause the glass strip to break. | | 7 | |
| VII. a | Building services are an integral part of any building which imparts serviceability conditions. If any of the following building services are defective, the entire building becomes unserviceable. The common services provided in buildings are<br>1) The vertical transport system such as stairs, escalators and lifts<br>2) HVAC (Heating, Ventilation and Air Conditioning) system.<br>3) Electrical system<br>4) Water supply system<br>5) Sewage and sullage disposal system<br>6) Communication system such as telephone. computer networks.<br>7) LPG distribution systems. | 1<br><br>7x1 | 8 | |

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| VII. b | The lift should be located at an easily accessible location in building, preferably in the entrance lobby. Earlier lifts were located near the stair case or ramp. But now there are distinctly locates to provide alternate access in the event of fire at any of the vertical transport systems. If there is more than one lift. It is generally provided in a cluster(group). The number of lifts required is decided based on various factors like quality of service required (mainly waiting time), RTT of the lift, passengers rush and importance of occupancy | | 7 | |
| VIII. a | Gas fuels like LPG and CNG are highly inflammable, they should be carried through pressure tested pipes. All joints should be tested for leaks. The joints should be preferably sealed using Teflon to ensure that it is airtight under the required pressure. For commercial tariff, gas meters are fitted to measure the consumption. The main advantage is that such systems can be directly connected to public gas supply system, or multiple LPG cylinders can be connected to a common supply system when a large number of stoves are connected as in the case of hotels, hostels or apartments. | | 8 | |
| VIII. b | The remedial measures are: properly designing the circuits and distribution system according to the connect load. The panel board distribution board, control switches, earthing, conductors and the conduits used should conform to BIS standards and specifications. The earthing efficiency should be checked with an earth Megger. The current and voltage ratings of safety devices such as MCCB (Moulded Case Circuit Breaker), MCB (Miniature Circuit Breaker), ELCB (Earth Leakage Circuit Breaker) etc. should be as per requirements and standards. Ensure that no short circuiting or sparking occurs in the circuit. | | 7 | |
| IX. a | **Foundation retrofitting**<br>1.Underground wall (beam) addition method: Connecting the foundation with cast-in-site diaphragm walls and connecting underground beams to distribute stress and to ensure the stability of the entire system.<br>2. Pile/footing addition construction method: When pile foundations are damaged or there is residual displacement, adding piles or footings to increase the load-carrying capacity of the foundation.<br>3.Foundation improvement method: Improving the ground around the foundation with cement improvement materials to improve the ground bearing capacity and horizontal foundation | Any 4<br>4x2 | 8 | |

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| | resistance. Also prevents excessive pore water pressure and liquefaction.<br>Steel sheet-pile coffering construction method: Placing sheet-piles around the periphery of the footing and bonding them to the footing to improve bearing capacity and horizontal resistance.<br>4.Foundation compacting method: When insufficient foundation bearing capacity is a concern due to scouring or the like, using concrete or similar materials to compact the ground around the foundation in order to restore bearing capacity.<br>5.Ground anchor method: When bridge abutments or similar structures move or tit laterally as a result of an earthquake or other disturbances, ground anchors are used to stabilize the bridge abutments | | | |
| IX. b | Retrofitting and restoration of buildings is necessary under the following conditions.<br>1) The building has become structurally unsafe<br>2) Dilapidated condition due to poor maintenance<br>3) Obsolescence<br>4) Severe damages due to natural calamities such as earthquakes, floods etc.<br>5) Human attack, such as terrorist attacks, wars etc.<br>6) Gradual deterioration of the building due to weathering<br>7) Changes in the functional utility of the building<br>8) Need for lifting or re-locating the building.<br>9) Preservation of historical heritage buildings<br>10) For enhancing the load carrying capacity of the existing building. | Any 7<br>7x1 | 7 | |
| X. a | • Lack of information or documents about the existing structure.<br>• Lack of expertise or skills in doing such works.<br>• Non-availability of suitable or appropriate material<br>• Dilapidated condition of the structure.<br>• Structural failures of existing structure.<br>• Neighbourhood constraint in carrying out retrofitting works.<br>• Compatibility issues between the existing structure and new work.<br>• Budget constraints<br>• Need for special workmanship.<br>• Unforeseen or hidden constraints like geological or geophysical factors, or difficulties in replacing certain components.<br>• Difficulty in attaining the original form and features | Any 8<br>8x1 | 8 | |

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| X. b | The main causes for deterioration are:<br>1) Deterioration due to climatic factors.<br>2) Natural calamities like floods and earthquakes<br>3) Lack of maintenance<br>4) War invasion and calamities<br>5) Misuse or damage caused by tourists<br>6) Lack of awareness<br>7) Pollution of air, soil and water<br>8) Lack of administrative will. | Any 7<br>7x1 | 7 | |

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