Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem: Odd Sem 2019-20 **Date**: 12.10.2019

Course Code: CIV 403 **Time**: 1.30 PM to 2.30 PM

Course Name: SUSTAINABLE MATERIALS AND GREEN BUILDINGS **Max Marks**: 40

Program & Sem: B.Tech & VII (OE) **Weightage**: 20%

Instructions:

(i) Read the question properly and answer accordingly.

(ii) Question paper consists of 3 parts.

(iii) Scientific and Non-programmable calculators are permitted.

Part A (Memory Recall Questions)

Answer all the Questions. Each Question carries three marks. (3Qx3M=9M)

1. Define sustainability. List three pillars of sustainability. (C.O.NO.1) [Knowledge]
2. Define Green building and List few examples of green buildings materials. (C.O.NO.2) [Knowledge]
3. List all the three goals of sustainable development. (C.O.NO.1) [Knowledge]

Part B (Thought Provoking Questions)

Answer all the Questions. Each Question carries five marks. (3Qx5M=15M)

4. List any five characteristics and selection criteria for a green building materials. (C.O.NO.2) [Knowledge]
5. Explain the challenges and opportunities for sustainable development? (C.O.NO.1) [Knowledge]
6. Define and explain the Ecological footprint in sustainable development. (C.O.NO.1) [Knowledge]

Part C (Problem Solving Questions)

Answer both the Questions. **(2Q=16M)**

7. Explain the manufacturing process of cement and also estimate the overall emission of one ton of carbon dioxide during the production of one ton of cement. [10 M]

(C.O.NO.2) [Knowledge]

8. Find equivalent factor of the areas given below [6 M]

(C.O.NO.1) [Knowledge]

Area	A	B	C	D
Biological Productivity	9Units	15Units	3Units	20Units
Size	2Units	3Units	5Units	2Units

SCHOOL OF ENGINEERING

Semester: ODD

Course Code: CIV 403

Course Name: Sustainable Materials and Green buildings

Date: 27/9/2019

Time: 1.00PM to 2.00PM

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit/Module Title	Memory recall type /Bloom's Levels	Thought provoking type /Bloom's Levels	Problem Solving type	Total Marks
		Introduction to environment and natural resources	K	K	K	
1	1	1	3	--	--	3
2	2	2	3	--	--	3
3	1	1	3	--	--	3
4	2	2	--	5	--	5
5	1	1	--	5	--	5
6	1	1	--	5	--	5
7	2	2	--	--	10	10
8	1	1	--	--	6	6
	Total Marks		9	15	16	40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

Annexure- II:

SCHOOL OF ENGINEERING

SOLUTION

Semester: ODD Semester 2019-20 | **Date**: 27/9/2019

Course Code: CIV 403 | **Time**: 1.00PM to 2.00PM

Course Name: Sustainable Materials and Green buildings | **Max Marks**: 40 | **Weightage**: 20%

Part A (3Q x3M =9Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	Sustainability is the ability to achieve continuing economic prosperity while protecting the natural systems of the planet and providing a high quality of life for its people. It looks to protect our natural environment, human and ecological health, while driving innovation and not compromising our way of life. • Environment • Society • Economy	1M 2M	3X4Min=12
2	Green building refers to both a structure and the using of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. Examples: Bricks, Flooring, Wall Finishes, Insulation etc.	3M	
3	There are three primary goals of sustainable development: 1. To minimize the depletion of natural resources when creating new developments. 2. To create development that can be maintained and sustained without causing further harm to the environment. 3. To provide methods for retrofitting existing developments to make them into environmentally friendly facilities and projects.		

Part B (3Q x 5M = 15Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
4	**Green building materials characteristic** •Reduced maintenance/replacement costs over the life of the building. • Energy conservation. • Improved occupant health and productivity. • Lower costs associated with changing space configurations. • It is made up of renewable materials. •It has minimum possible environmental cost. •It has low energy utilization in its manufacturing as well as its functioning. • Greater design flexibility. • It is easily recyclable. • It is efficient in the long run. **Selection criteria for green building material** **Local availability of materials**:- The transport component is a major contribution of the green house gases ,hence the locally available material should be used. **Embodied energy of materials**:- The embodied energy of the product should be as least as possible. **% of recycled/waste materials used**:- The percentage of recyclable materials used in the construction should be maximum. **Rapidly renewable materials**:- Renewable materials ,compared to conventional emit less Carbon-dioxide. **Contribution in energy efficiency of building**:- The energy efficient materials ,help in reducing the usage of electricity. **Recyclability of materials**:- Products with identifiable recycled content should be used. **Durability**:- Materials that are longer lasting or are comparable to conventional products with long life expectancies **Environmental Impact** - An Ideal green building material is a material which has no negative environmental impacts. Possibly it should have positive environmental impacts. Further such material should be infinitely reusable or recyclable. But such ideal materials are rarely available. However materials which can eliminate or reduce negative impacts can be considered as green building materials.	2.5M 2.5M	9minx3Q=27min
5	**Challenges and Opportunities for Sustainability in practice** Sustainability presents many challenges to us from the economic perspective. In particular, there are four types of economic issues that		

	we see routinely in environmental problems and that affects our ability to develop more sustainable solutions. 1. The fundamental affordability of greener products, technologies and systems. 2. The opportunity cost of money and the way individuals and businesses make decisions about how to invest and spend their money. 3. The problem of externalities and the fact that the burden of environmental degradation is not generally reflected in the prices of the goods and services that we buy. 4. The difficulty in establishing a monetary value for clean, healthy environment and sustainable business practices. Engineers are often frustrated by theses economic factors, especially when they have designed a product or process that reflects a high degree of technical efficiency or reduces impacts on the environment. • **The fundamental affordability of Greener goods and services** When considering the entire world, huge no. of people are below poverty line. For them it's very difficult to spent scarce house hold cash to sustainable development instead of buying necessity items. Basic fact is that if you have no money, you cannot afford to buy something even if it is of great benefit to you. Going to the market and thinking about buying a refrigerator with energy efficient but cost is 50% more than the normal one, or going to buy an automobile with energy efficient and less polluting technology but cost is 2 times higher than polluter car. Ability to pay is also a consideration because more sustainable products, goods and services often carry Green Premium, which is why they are more costly than normal products and services. Moreover people value what they are willing to pay for. By taking it as opportunity government organisations like grameena shakthi takes initiative of installing Solar PV panels and biogas plants. They also provide subsidies for installing technology and take small amount of interest annually. • **The Opportunity cost of money** Opportunity cost is an economic concept that represents what we gain or loss by choosing one option over another. There is always an opportunity cost hidden behind all economic decision. So it is important consideration in our analyses of why sustainable products, services, buildings and industrial practices do not rapidly hold. Green premium of environmental friendly goods and services acts as an adoption barrier for people and organisations for which opportunity cost of green purchase is high. Since green premium is unavoidable, one of the several things must happen in order to motivate people to spend more money up-front and	5M	

	change their perception of opportunity cost. First step, is green marketing products labelled as 'Eco-friendly' or Endorsement labelling like Energy stars for product which meets specific sustainability criteria. Thus easily comply with their own environmental management goals. Second step is to demonstrate the long term benefits of more sustainable choice. For example Benefit-cost analysis, there are many techniques for comparing the long term advantages and disadvantages of different economic choices. Methods used are Life cycle analysis and return on investment ratio. Benefit cost analysis works well for analysing many kind of sustainability choices, even though consumers and companies are not able to afford the more costly product up-front. Consumer may not have time to evaluate a long term economic benefits. Industry under pressure to compete and make profits in short term. • **The problem of externalities** Negative externality is the harmful environmental impacts or the harm associated with the process. For example, large amount of SO_2 released from the thermal power plant, which leads to respiratory diseases, health effects, acid rain etc. The price of electricity to the consumer simply reflects the cost of the utility of making energy and as a modest rate of profit. Society from negative externalities and market failures. Environmental population laws that limit pollutants (clean air act in US limited SO_2 emissions). Emission standards, regulations through permits, Licenses, Fees, penalties for violation limits the emission of pollutants to the atmosphere to an extent. Cap and trade market mechanism adopted in US regarding the SO_2 emission from power plant reduce the overall emission by 40%. In cap and trade system, established permanent maximum yearly limit on SO_2 emission, that is Cap. If they emit more than the allowance (cap), subjected to penalty with high fine. Moreover these allowances are tradable, polluter emits less SO_2 can sell their extra allowances or bank for future. Government can promote the concept of Renewable energy credits (RECs) (it is 1MW of electric power generated by a clean energy source). • **The difficulty of Environmental Valuation** It is very difficult to establish monetary value and account the clean environment and sustainability. Social and environmental accounting among 3 pillars how business activity benefits people and environment. Ecological foot print is such an indicator. Even though require more accurate methods for assessing the social and environmental outcomes of business practice.	2M 3M	
6.	**The Ecological Footprint is a measure of how much biologically productive land and water area an individual, a city, a country, a region, or humanity uses to produce the resources it consumes and**		

	to absorb the waste it generates, using prevailing technology and resource management. It measures how fast we consume resources and generates waste. The Ecological Footprint has emerged as the world's premier measure of humanity's demand on nature. This accounting system tracks, on the demand side i.e. how much land and water area a human population uses, to provide all it takes from nature. This includes the areas for producing the resource it consumes, the space for accommodating its buildings and roads, and the ecosystems for absorbing its waste emissions such as carbon dioxide. These calculations account for each year's prevailing technology, as productivity and technological efficiency change from year to year. Ecological Footprint accounting measures the *demand* on and *supply* of nature. On the demand side, the **Ecological Footprint** measures the ecological assets that a given population requires to produce the natural resources it consumes (including plant-based food and fibre products, livestock and fish products, timber and other forest products, space for urban infrastructure) and to absorb its waste, especially carbon emissions. The Ecological Footprint tracks the use of six categories of productive surface areas: cropland, grazing land, fishing grounds, built-up land, forest area, and carbon demand on land. On the supply side, a city, state or nation's **bio-capacity** represents the productivity of its ecological assets (including cropland, grazing land, forest land, fishing grounds, and built-up land). These areas, especially if left unharvested, can also absorb much of the waste we generate, especially our carbon emissions. Both the Ecological Footprint and bio-capacity are expressed in **global hectares (gha)**—globally comparable, standardized hectares with world average productivity.		

Part C

Q No	**Solution**	**Scheme of Marking**	**Max. Time required for each Question**

7			15min
	• Rotary Kiln Diagram	3M	
	• Lime stone decomposition	3M	
	• Coal oxidation	3M	
	• Total one ton CO_2 per one ton of cement production	1M	
8	Production/unit area	2M	
	Average biomass production	2M	6min
	Area A=1.15		
	B=1.28		
	C=0.15		
	D=2.55	2M	

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GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY
BENGALURU
SCHOOL OF ENGINEERING
TEST –2

Semester & AY: Odd Sem 2019-20
Course Code: CIV 403
Course Name: SUSTAINABLE MATERIALS AND GREEN BUILDINGS
Program & Sem: B Tech (Civil) & VII Sem

Date: 16.11.2019
Time: 1.00 PM to 2.00 PM
Max Marks: 40
Weightage: 20%

Instructions:
(i) Read the question properly and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and Non-programmable calculators are permitted.

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries three marks. (3Qx3M=9M)

1. Define LCA and list the scope of Life cycle analysis? (C.O.NO.1)[Knowledge]
2. What is recycled aggregates and list the properties of recycled aggregates. (C.O.NO.2)[Comprehension]
3. List benefits of ISO 14001 series. (C.O.NO.1)[Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each question carries four marks. (3Qx4M=12M)

4. Name and explain any one type of manufactured aggregate. (C.O.NO.2)[Comprehension]
5. Explain life cycle impact assessment based on:
   a. Baseline impact category
   b. Study specific impact category (C.O.NO.1)[Comprehension]
6. Write short note on Environmental Management System and its benefits. (C.O.NO.1)[Knowledge]

Part C [Problem Solving Questions]

Answer both the Questions. Two questions carries nineteen marks. (1Q*9M+1Q*10M=19)

7. Define global warming. What are the effects and brief remedial measures for global warming? (C.O.NO.1)[Knowledge]
8. Explain in detail: a) HVFA Concrete b) Geopolymer concrete.(C.O.NO.2)[Comprehension]

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

Semester: ODD

Course Code: CIV 403

Course Name: Sustainable Materials and Green buildings

Date: 16/11/2019

Time: 1.00PM to 2.00PM

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit/Module Title	Memory recall type /Bloom's Levels	Thought provoking type /Bloom's Levels	Problem Solving type	Total Marks
		life cycle analysis/ Green Building construction and materials	K	K	K	
1	1	1	3	--	--	3
2	2	2	3	--	--	3
3	1	1	3	--	--	3
4	2	2	--	4	--	4
5	1	1	--	4	--	4
6	1	1	--	4	--	4
7	1	1	--	--	9	9
8	2	2	--	--	10	10
	Total Marks		9	15	19	40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

Annexure- II:

SCHOOL OF ENGINEERING

SOLUTION

Semester: ODD Semester 2019-20

Course Code: CIV 403

Course Name: Sustainable Materials and Green buildings

Date: 16/11/2019

Time: 1.00PM to 2.00PM

Max Marks: 40

Weightage: 20%

Part A (3Q x3M =9Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	**Life-cycle assessment (LCA,** also known as **life-cycle analysis, ecobalance**, and **cradle-to-grave analysis)** is a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. Scope of LCA may range from. • Raw materials extraction to the disposal of finished goods (cradle to grave) • Raw materials extraction to finished goods (cradle to gate) • One process stage to another (gate to gate)	1M 2M	3QX4Min=12
2	*Recycled aggregate is produced as a result of crushing the inorganic particles processed from the materials that have been used in the constructions.* 2M	1M	
3	**ISO 14001- Benefits**	3M	

Property	Natural Aggregates	Recycled Aggregates
Shape and Texture	Well rounded ,smooth to angular and rough	Angular with rough surface
Absorption Capacity	0.8-3.7 %	3.7-8.7 %
Specific Gravity	2.4-2.9	2.1-2.4
L. A. Abrasion Test Mass Loss	15-30 %	20-45 %

	• Achieve strategic business aims by incorporating environmental issues into business management • Provide a competitive and financial advantage through improved efficiencies and reduced costs • Encourage better environmental performance of suppliers by integrating them into the organization's business systems		

Part B (3Q x 5M = 15Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
4	Manufactured aggregates are the end by-product of an industrial process which are used in construction. (Usually coarse aggregate size) Examples are Slag, Dross. Slag is a byproduct of the steel making process. Dross is a byproduct of Tin. **PHYSICAL PROPERTIES SLAG** • The physical properties of slag are largely controlled by how it cools and solidifies. The color of slag coarse aggregate usually varies from *light to dark grey.* • The aggregate particles have a very rough texture. • The shape is *angular and roughly cubical.* • The Los Angeles (L.A.) abrasion values for slag typically range between *35 and 45 percent* • The density is 1200 to 1400 kg/m^3(This makes it suitable, for usage of a light weight concrete production) • The Compressive strength tends to increase with increase percentages up to 30% of iron slag in the mix. • The moisture absorption is about **3 to 5 %.**	1M 3M	3QX 7min=21min
5	**Life Cycle Impact Assessment** Inventory analysis is followed by impact assessment. This phase of LCA is aimed at evaluating the significance of potential environmental impacts based on the LCI flow results. Classical life cycle impact assessment (LCIA) consists of the following mandatory elements: • **Impact category definition:** 1. Group A : Baseline impact categories These are typically found in almost all LCA studies and include the following		

	○ Depletion of abiotic resources ○ Impacts of land use ○ Climate change ○ Stratospheric ozone depletion ○ Human toxicity ○ Ecotoxicity ○ Acidification ○ Eutrophication 2. Group B : Study specific impact categories These may be included depending on the goal and scope of the LCA and on whether data is available. ○ Impacts of land use ○ Ecotoxicity ○ Impacts on radiation ○ Odor (air) ○ Noise ○ Waste heat ○ Casualties	2M 2M	
6.	**Environmental management system (EMS)** An environmental management system helps organizations identify, manage, monitor and control their environmental issues in a holistic manner. It also includes the need for continual improvement of an organization's systems and approach to environmental concerns. **Benefits of EMS** • Assurance to customers • Increase legal compliance • Good public/community relations • Satisfying investors and access to capital • Enhancing image and market share • Reducing liability • Improving cost control • Conserving materials and energy • Facilitating the attainment of permits/authorization • Improving government-industry relations	1M 3M	

Part C

Q No	Solution	Scheme of Marking	Max. Time required for each Question
7	**Global warming**, the phenomenon of increasing average air temperatures near the surface of Earth over the past one to two	1M	12min

	centuries. Climate scientists have since the mid-20th century gathered detailed observations of various weather phenomena. Following are the effects of global warming: 1. More heat waves 2. Expansion of desert area 3. Natural fires in forest lands 4. More evaporation of water from oceans and water bodies 5. Melting of Ice caps in Arctic and Antarctic regions 6. More cloud formation in the atmosphere 7. Shorter and warmer winters coupled with longer and hotter summers 8. Changes in rainfall pattern 9. Rise in sea level 10. Flooding and submergence of low lying coastal areas 11. Disruption in farming 12. More drought 13. Impact on plants, animals and humans	4M	
	Control and remedial measures: Some of the remedial and control measures of global warming are listed below: 1. Reduction in consumption of fossil fuels such as coal and petroleum 2. Use of bio-gas plants 3. Support public transport, car pooling etc. 4. Increasing forest cover 5. Use of unleaded petrol in automobiles 6. Installation of pollution controlling devices in automobiles (catalytic converter) and industries (Electro Static Precipitators, Bag filters, Wet scrubbers etc)	4M	
8	**High volume Fly ash concrete(HVFA)** High volume fly ash (HVFA) concrete uses high volumes of fly ash to replace the Portland cement content. Replacement levels as high as 60% has been reported to be successful . • Concrete containing **more than 50% of** fly ash content by mass of the total cementitious materials is considered as High Volume Fly ash Concrete (HVFAC). • But **IS 456** allows the replacement till 35 %. • Experimental results show that, HVFAC has lower strength at early ages but at later age HVFAC shows continuous increase in strength properties.	5M	15min

- Significantly both the crack width and drying shrinkage reduce and thus contribute to the long term durability of concrete.
- The HVFA concrete is more suitable for warm weathers and where early strength is not essential.
- Fly ash reduces the amount of water required by about 15 to 20% and improves workability by "ball bearing action" of spherical fly ash particles.
- The most attractive property of HVFA is improvement in durability due to the reduction of **Calcium Hydroxide.**
- Resistant to Corrosion and Sulphate Attack
- The setting time for the HVFA concrete is higher than PCC by **about 2 hrs.**

Geopolymer Concrete

- Geopolymer cement concrete is made from utilization of waste materials such as ***fly ash and ground granulated blast furnace slag (GGBS).***

Composition of Geopolymer Concrete

- Fly ash – A byproduct of thermal power plant
- GGBS – A byproduct of steel plant
- Fine aggregates and coarse aggregates as required for normal concrete.
- **Alkaline activator solution** for GPCC. Catalytic liquid system is used as alkaline activator solution. It is a combination of solutions of ***alkali silicates and hydroxides***, besides distilled water.

5M

The alkaline liquids are from ***soluble alkali metals that are usually Sodium or Potassium based.***

The most common alkaline liquid used in geopolymerisation is a combination of ***sodium hydroxide (NaOH) or potassium hydroxide*** (KOH) and ***sodium silicate or potassium silicate***.

The silicon and aluminum oxides in the GGBFS and Fly ash reacts with the alkaline liquid to form the geopolymer paste that binds the loose coarse aggregates, fine aggregates, and other un-reacted materials together to form the geopolymer concrete.

-Hot curing method is preferred for Geopolymer concrete.

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SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 2020 | **Date**: 23 December 2019

Course Code: CIV 403 | **Time**: 9:30 AM to 12:30 PM

Course Name: SUSTAINABLE MATERIALS AND GREEN BUILDINGS | **Max Marks**: 80

Program & Sem: B Tech (All Program) & VII (OE-I) | **Weightage**: 40%

Instructions:

(i) Read the all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and Non-programmable calculators are permitted.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 4 marks. (5Qx4M=20M)

1. List the primary goals of sustainable development. (C.O.No.1) [Knowledge]

2. List any four characteristic of Green building materials? (C.O.No.2) [Knowledge]

3. What is Zero Energy Building and List any three energy saving features.

(C.O.No.3) [Comprehension]

4. Define ventilation and explain types of ventilation for indoor system.

(C.O.No.4) [Comprehension]

5. List any four passive and active measures to reduce operational energy demand of a building. (C.O.No.4) [Comprehension]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 5 marks. (6Qx5M=30M)

6. Define Embodied energy and write a note on its components. (C.O.No.1) [Knowledge]

7. List and explain any five selection criteria for green building material. (C.O.No.2) [Knowledge]

8. What is IGBC, list any five parameters considered for rating a Green Building and its certification system? (C.O.No.3) [Comprehension]

9. List the methods to make a buildings green and explain any two in detail.

(C.O.No.3) [Comprehension]

10. Define ventilation and explain types of ventilation for indoor system.
(C.O.No.4) [Comprehension]

11. Explain the production of biodiesel with chemical equations. (C.O.No4) [Comprehension]

Part C [Problem Solving Questions]

Answer all the Questions. Each Question carries 10 marks. (3Qx10M=30M)

12. Explain Carbon cycle and its components. (C.O.No.1) [Knowledge]
13. What is LEED, explain the parameters considered for rating a Green Building and its certification System. (C.O.No.3) [Comprehension]
14. Explain life cycle energy use of a building in different phases in terms of energy usage.
(C.O.No.4) [Comprehension]

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1	1	1	4			4
2	2	2	4			4
3	3	3		4		4
4	4	4		4		4
5	4	4		4		4
6	1	1	5			5
7	2	2	5			5
8	3	3		5		5
9	3	3		5		5
10	4	4		5		5
11	4	4		5		5
12	1	1	10			10
13	3	3		10		10
14	4	4		10		10
	Total Marks					80

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

Reviewer Commend:

Answer Scheme

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SOLUTION

Semester : Odd Semester: 2019 - 2020
Course Code: CIV 403
Course Name: Sustainable Materials and Green buildings
Program & Sem: B Tech(Civil) 7th Sem

Date: 23rd Dec 2019
Time:9.30 am to 12.30pm
Max Marks: 80
Weightage: 40%

Part A (5Q x 4M = 20Marks)

Q No	Solution	Scheme of Marking	Max. Time require for each Question
1	**There are three primary goals of sustainable development**: 1. To minimize the depletion of natural resources when creating new developments. 2. To create development that can be maintained and sustained without causing further harm to the environment. 3. To provide methods for retrofitting existing developments to make them into environmentally friendly facilities and projects.	**4M**	
2	**Characteristic of Green building materials** • Energy conservation. • Reduced maintenance/replacement costs over the life of the building. • Improved occupant health and productivity. • Lower costs associated with changing space configurations. • It is made up of renewable materials. • It has minimum possible environmental cost. • It has low energy utilization in its manufacturing as well as its functioning. • Greater design flexibility. • It is easily recyclable. • It is efficient in the long run.	**4M**	
3	**Zero Energy Building:** A zero-energy building (also known as a zero net energy building) is a building with zero net energy consumption, meaning the total amount of energy used by the building on an annual basis is roughly equal to the amount of renewable energy created on the site. Net zero Energy = (-)Consumed Energy (+) Produced Energy = Zero **Zero-energy buildings features** • The heating and cooling loads are lowered by using high-efficiency equipment. • Insulation • High-efficiency windows(double Glazed Glass) • High-efficiency LED lighting • Choosing efficient appliances • On-site energy harvesting such as with roof top mounted solar panels	**1M** **3M**	

	• Motion sensors usage.		
4	**Ventilation:** A process, whereby air is supplied and removed from an indoor space by natural or mechanical means. **Types of Ventilation** 1. Natural 2. Mechanical **Natural Ventilation** It involves Infiltration: random/ intentional flow of outdoor air through windows, cracks and a variety of openings in the buildings. Exfiltration: movement of air from indoor spaces to outdoor. **Mechanical Ventilation** It involves • Pulling fresh air from outside to indoor spaces. • Exhaust stale air. • Control temperature and humidity inside.	**1M** **1.5MX2M= 3M**	
5	**To reduce operational energy demand of the buildings, passive and active measures such as providing** 1.Higher insulation on external walls and roof. 2. Radiant Barriers and Reflective Insulation Systems 3.Using gas filled multiple pane windows with low emissivity (LE) coatings. 4.Ventilation air heat recovery from exhaust air, heat pumps coupled with air or ground/water heat sources, 5.Solar thermal collectors and building integrated solar photovoltaic panels.	**4M**	

Part B (6Q x 5M = 30Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
6	**Embodied energy** is the total energy required for the extraction, processing, manufacture and delivery of building materials to the building site. **Components of Embodied Energy** • Extraction, • Processing, • Manufacture and • Delivery of building materials • Embodied energy is the total energy required for the extraction, processing, manufacture and delivery of building materials to the building site. • Energy consumption produces CO_2, which contributes to greenhouse gas emissions, so embodied energy is considered an indicator of the overall environmental impact of building materials and systems. • Unlike the life cycle assessment, which evaluates all of the impacts over the whole life of a material or element, embodied energy only considers the front-end aspect of the impact of a building material. It does not include the operation or disposal of materials.	**1M** **4M**	

7	**Selection criteria for green building material** • **Local availability of materials**:- The transport component is a major contribution of the green house gases ,hence the locally available material should be used. • **Embodied energy of materials**:- The embodied energy of the product should be as least as possible. • **% of recycled/waste materials used**:- The percentage of recyclable materials used in the construction should be maximum. • **Rapidly renewable materials**:- Renewable materials ,compared to conventional emit less Carbon-dioxide. • **Contribution in energy efficiency of building**:- The energy efficient materials ,help in reducing the usage of electricity. • **Recyclability of materials**:- Products with identifiable recycled content should be used. • **Durability**:- Materials that are longer lasting or are comparable to conventional products with long life expectancies • **Environmental Impact -** An Ideal green building material is a material which has no negative environmental impacts. Possibly it should have positive environmental impacts. Further such material should be infinitely reusable or recyclable. But such ideal materials are rarely available. However materials which can eliminate or reduce negative impacts can be considered as green building materials. • Life Cycle Assessment(Assessment of the environmental Impacts)	**5MX1M=5M**	
8	**IGBC(Indian Green Building council)** IGBC has set up the Green New Buildings Core Committee under the leadership of Ar. Raghavendran, to develop the rating programme. This committee comprised of key stakeholders including architects, builders, consultants, developers, owners, institutions, manufacturers and industry representatives. The committee, with a diverse background and knowledge has enriched the rating system, both in its content and process **IGBC Green New Buildings rating system addresses green features under the following categories:** 1.Sustainable Architecture and Design 2.Site Selection and Planning 3.Water Conservation 4.Energy Efficiency 5.Building Materials and Resources 6.Indoor Environmental Quality 7.Innovation and Development	**5MX1M=5M**	
9	**Methods to make a buildings green** **1. Taking an intelligent approach to energy** Minimising energy use in all stages of a building's life-cycle, making new and renovated buildings more comfortable and less	**5MX1M=5M**	

	expensive to run, and Integrating renewable and low-carbon technologies to supply buildings' energy needs. **2. Safeguarding water resources** Minimising energy use in all stages of a building's life-cycle, making new and renovated buildings more comfortable and less expensive to run, and helping building users learn to be efficient too. **3. Minimising waste and maximising reuse** Using fewer, more durable materials and generating less waste, as well as accounting for a building's end of life stage by designing for demolition waste recovery and reuse **4. Considering all stages of a building's life-cycle** Seeking to lower environmental impacts and maximise social and economic value over a building's whole life-cycle (from design, construction, operation and maintenance, through to renovation and eventual demolition). **5.Connecting communities and people** Ensuring transport and distance to amenities are considered in design, reducing the impact of personal transport on the environment, and encouraging environmentally friendly options such as walking or cycling.		
10	<table><tr><th>Pollutant</th><th>Effect</th><th>Limits</th></tr><tr><td>No_x</td><td>Irritation to the skin, eyes and throat, cough</td><td>0.05 mg/l</td></tr><tr><td>Radon</td><td>Lung cancer</td><td>9 mg/l</td></tr><tr><td>VOCs</td><td>Liver, kidney disorders, irritation to the eyes, nose and throat, skin rashes and respiratory problems.</td><td>5 g/cu.m</td></tr><tr><td>O_3(Ozone)</td><td>eyes itch, burn, respiratory disorders, lowers our resistance to colds and pneumonia</td><td>100 g/cu.m</td></tr><tr><td>Carbon monoxide</td><td>headache, shortness of breath, higher conc. May cause sudden deaths.</td><td>9.0 mg/l</td></tr></table>	**5MX1M=5M**	
11	***Biodiesel*** Biodiesel is an alternative fuel similar to conventional or 'fossil' diesel.Biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil.The process used to convert these oils to Biodiesel is called transesterification. **Production of Biodiesel** Transesterification process is the reaction of a triglyceride (fat/oil) with an alcohol to form esters and glycerol. The products of the reaction are the biodiesel(Ester) itself and glycerol. Catalyst, usually a strong alkaline like sodium hydroxide. Glycerine + Alcohol ⟹ Sodium Hydroxide Catalyst ⟹ Ester + Glycerol (Vegetable oil) (Biodiesel)	**5MX1M=5M**	

Part C (3Q x 10M = 10Marks)

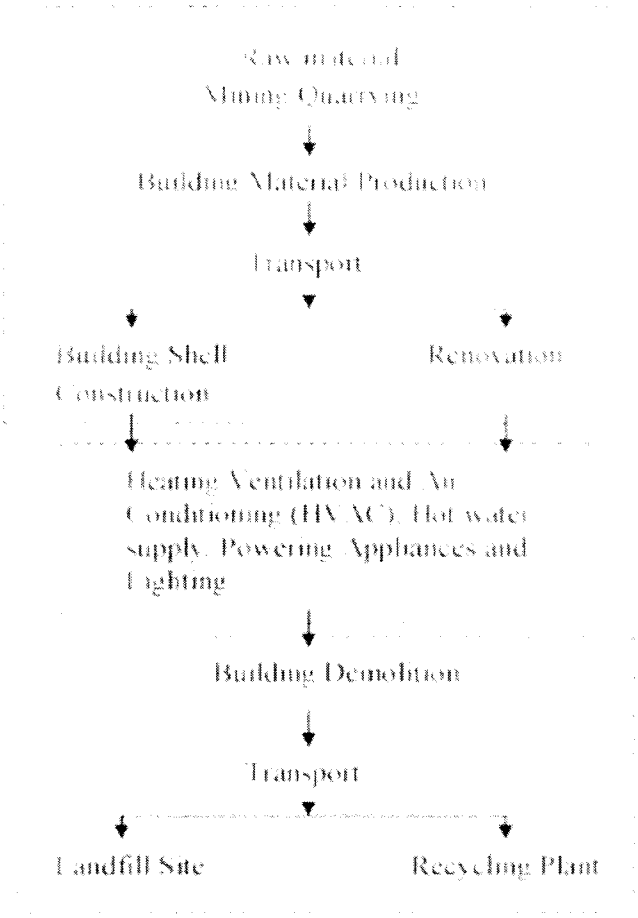
Q No	Solution	Scheme of	Max. Time require

		Marking	for eacl Questio
12	❖ **Carbon Cycle** The **carbon cycle** is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth. Carbon is the main component of biological compounds as well as a major component of many minerals such as limestone. Along with the nitrogen cycle and the water cycle, the carbon cycle comprises a sequence of events that are key to make Earth capable of sustaining life. Carbon cycle components are: • The atmosphere • The biosphere • The ocean, including dissolved inorganic carbon and living and non-living marine biota • The Earth's interior (mantle and crust. These carbon stores interact with the other components through geological processes. **Atmosphere** Carbon in the Earth's atmosphere exists in two main forms: carbon dioxide and methane. Carbon dioxide is removed from the atmosphere primarily through photosynthesis and enters the terrestrial and oceanic biospheres. Carbon dioxide also dissolves directly from the atmosphere into bodies of water (ocean, lakes, etc.), as well as dissolving in precipitation as raindrops fall through the atmosphere. When dissolved in water, carbon dioxide reacts with water molecules and forms carbonic acid, which contributes to ocean acidity. It can then be absorbed by rocks through weathering. It also can acidify other surfaces it touches or be washed into the ocean. Human activities over the past two centuries have significantly increased the amount of carbon in the atmosphere, mainly in the form of carbon dioxide, both by modifying ecosystems' ability to extract carbon dioxide from the atmosphere and by emitting it directly, e.g., by burning fossil fuels and manufacturing concrete. **Biosphere** The terrestrial biosphere includes the organic carbon in all land-living organisms, both alive and dead, as well as carbon stored in soils. Most carbon in the terrestrial biosphere is organic carbon, while about a third of soil carbon is stored in inorganic forms, such as calcium carbonate. Organic carbon is a major component of all organisms living on earth. Autotrophs extract it from the air in the form of carbon dioxide, converting it into organic carbon, while heterotrophs receive carbon by consuming other organisms. **Ocean** Carbon enters the ocean mainly through the dissolution of atmospheric carbon dioxide, a small fraction of which is converted into carbonate. It can also enter the ocean through rivers as dissolved organic carbon. It is converted by organisms into organic carbon through photosynthesis and can either be exchanged throughout the food chain or precipitated into the ocean's deeper, more carbon rich layers as dead soft tissue or in shells as calcium carbonate. **Earth interior** Most of the earth's carbon is stored inertly in the earth's lithosphere. Much of the carbon stored in the earth's mantle was stored there when the earth formed. Some of it was deposited in the form of organic carbon from the biosphere. Of the carbon stored in the geosphere, about 80% is limestone and its derivatives, which form from the sedimentation of calcium carbonate stored in the shells of marine organisms.	10M	

13	**LEED (Leadership in Energy and Environmental Design)** It is an internationally recognized green building certification system, provides third-party verification that a community or building was designed and built using strategies aimed at improving performances in energy savings, water efficiency, CO2 emissions/ reductions, improved indoor environmental quality, and stewardship of resources and sensitivity to their impact. LEED (Leadership in Energy and Environmental Design) **A LEED Certified building can reduce** 1.Energy use by 25%- 50 % 2.Carbondioxide emission by 33-39% 3.Water use by 40% 4.Solidwaste by 70% **Rating System and Criteria(Parameters for rating)** **1.Sustainable Sites** -Discourages development on previously undeveloped land -minimizes a building's impact on ecosystems and waterways **2.Water Efficiency** The goal is to encourage smarter use of water inside and out **3.Energy and Atmosphere** - Monitoring of energy use - Efficient design and construction - Efficient appliances, systems, and lighting - Use of renewable and clean sources of energy, generated onsite or off-site **4. Materials and Resources** It encourages the selection of sustainably grown, harvested, produced, and transported products and materials - Promotes reduction of waste as well as reuse and recycling - It takes into account reduction of waste at a product's source **5. Indoor Environment Quality** -It promotes strategies that can improve indoor air as well as providing access to daylight and views and improving acoustics **6. Locations and Linkages** -It encourages homes being built away from environmentally sensitive areas • instead, being built in infill, previously developed, and other sites **7. Innovation in Design** -It provides bonus points for projects that use new and innovative technologies and strategies to improve a building's performance beyond what is required by LEED credits or green building considerations that are not specifically elsewhere in LEED	10M	

14	**Life cycle energy use of building** Life cycle energy analysis is an approach that accounts for all energy inputs to a building in its lifecycle. The system boundaries of this analysis include the energy use of the following phases: 1.Manufacture Energy(EEi) 2.Operational Energy(EEr) 3.Demolition 1. Manufacture phase Manufacture Energy of materials refers to the energy used to acquire raw materials (excavation), manufacture and transport to the building site i.e Embodied Energy. Embodied Energy is divided in two parts -Initial embodied energy -Recurring embodied energy **2.Operational Energy (OE)** • It is the energy required for maintaining comfort conditions and day-to-day maintenance of the buildings. It is the energy for HVAC (heating, ventilation and air conditioning), domestic hot water, lighting, and for running appliances. • Operational energy largely varies on the level of comfort required, climatic conditions and operating schedules. **3.Demolition energy(DE)** • At the end of buildings' service life, energy is required to demolish the building and transporting the waste material to landfill sites and/or recycling plants. **Total Life Cycle Energy** • Life cycle energy of the building is the sum of the all the energies incurred in its life cycle. • It is thus expressed as: **LCE=EEi +EEr +OE+DE** By performing life cycle energy analysis, the phases that have highest energy demand can be identified and targeted for improvement.Life cycle energy**, if quantified** in terms of primary energy can give a useful indication of the **greenhouse gas** emissions attributable to buildings and therefore its impact on the environment.	**6M**	

4M


Raw material
Mining Quarrying
Building Material Production
Transport
Building Shell
Construction
Renovation
Heating Ventilation and Air
Conditioning (HVAC), Hot water
supply, Powering Appliances and
Lighting
Building Demolition
Transport
Landfill Site
Recycling Plant
Manufacturing
Phase
Use Phase
Demolition
Phase