TABLE OF CONTENTS

SYLLABUS

SYLLABUS FOR DIPLOMA AND D. VOC STUDENTS

BASICS OF CIVIL & MECHANICAL ENGINEERING (30 marks)

MODULE 1

General Introduction to Civil Engineering: Relevance of Civil Engineering in the overall infrastructural development of the country. Responsibility of an engineer in ensuring the safety of built environment. Brief introduction to major disciplines of Civil Engineering like Transportation Engineering, Structural Engineering, Geo-technical Engineering, Water Resources Engineering and Environmental Engineering.

Introduction to buildings: Types of buildings, selection of site for buildings, components of a residential building and their functions.

Building rules and regulations: Relevance of NBC, KBR & CRZ norms (brief discussion only).

Building area: Plinth area, built up area, floor area, carpet area and floor area ratio for a building as per KBR.

MODULE 2

Surveying: Importance, objectives and principles.

Construction materials, Conventional construction materials: types, properties and uses of building materials: bricks, stones, cement, sand and timber

Cement concrete: Constituent materials, properties and types.

Steel: Steel sections and steel reinforcements, types and uses.

Modern construction materials:- Architectural glass, ceramics, Plastics, composite materials, thermal and acoustic insulating materials, decorative panels, waterproofing materials. Modern uses of gypsum, pre fabricated building components (brief discussion only).

MODULE 3

Building Construction: Foundations: Bearing capacity of soil (definition only), functions of foundations, types – shallow and deep (brief discussion only). Load bearing and framed structures (concept only).

Brick masonry: - Header and stretcher bond, English bond & Flemish bond, Random rubble masonry.

Roofs and floors: - Functions, type; flooring materials (brief discussion only).

Basic infrastructure services: MEP, HVAC, elevators, escalators and ramps (Civil Engineering aspects only), fire safety for buildings.

Green buildings:- Materials, energy systems, water management and environment for green buildings. (brief discussion only).

BASICS OF CIVIL ENGINEERING

Weightage : 15 Marks

MODULE 1

1. GENERAL INTRODUCTION TO CIVIL ENGINEERING

"Civil Engineering is the art of directing great source of nature for use and convenience of man".

Civil Engineers contribute more to shape the civilization than any other professional group.

They contribute basic Infrastructure facilities include,

- Good surface communication links such as tar or concrete roads.
- Provision of water supply distribution system i.e., construction of water storage reservation or sumps, laying of underground pipes etc.
- Provision of a drainage system which may include construction of surface drains as subsurface drains for the disposal of wastewater.
- Supply of electrical power for which construction of transmission line towers, construction of electrical substations.
- Providing inland communications lines, i.e., telephone lines etc.
- Construction of recreational places e.g., gardens, parks etc.

1.1. RESPONSIBILITY OF CIVIL ENGINEER

Various responsibility of civil engineers in ensuring the safety of built engineering are

a) Investigation

To collect necessary data before the planning of a project

b) Surveying

Prepare maps and plans to locate various structures of a project on the surface of earth

c) Planning

Depending upon the result obtained from investigation and surveying, a civil engineer should prepare the necessary drawing for the project with respect to capacity, size and location of its various components

d) Design

After planning, safe dimensions of the components required are worked out with the dimension, a detailed drawing is prepared for various components.

e) Execution

This function deals with preparation of schedules for the construction activities, floating of tenders, finalization of contracts, supervision of construction works, preparation of bills.

f) Research and development

Civil engineer has to engage in the research and development to achieve economy and to improve the efficiency to meet the present and future needs.

1.2. MAJOR DISCIPLINES OF CIVIL ENGINEERING

The field of civil engineering can broadly be divided into many major branches according to the functions performed.

a) Structural Engineering

The construction of a structure needs efficient planning, design and method of construction. Major steps in any construction project include

a) Positioning and arranging the various

parts of a structure into a definite form.

b) Finding out magnitude, direction and nature of various forces acting on the structure.

c) Analysing the structure to know the behaviour of various parts of the structure.

d) Designing the structure such that its stability under the action of various loads is ensured.

e) Executing the work with selected construction material and skilled workers.

b) Geotechnical Engineering

- Geotechnical engineering deals with analysis, design and construction of foundation.
- The study of engineering behaviour of soil and rock is known a geotechnical engineering.
- The study of soil alone is Soil Mechanics and behaviour of foundation is foundation engineering.
- Geotechnical engineer evaluates potential settlements of buildings, the stability of slopes and hills, the seepage of ground water and the effects of earthquakes.
- They investigate rocks and soils at a project site and determine the best way to support a structure in the ground.
- They also take part in the design and construction of dams, embankments and retaining walls.

c) Hydraulics Engineering

- It is a sub-discipline of civil engineering concerned with the flow and conveyance of fluids, mainly water.
- It is intimately related to the design of bridges, dams, channels, canals, levees elevators etc.

d) Hydrology and Irrigation

- Hydrology is the study of the prediction, movement, distribution, and quality of water throughout earth.
- Prediction of weather, measurement of rainfall, estimation of ground water flow etc. comes under hydrology.
- Irrigation engineering deals with the analysis and design of irrigation systems which include dams, weir, barrage, canals, drains etc.
- The economic use of water for crop growth is done in irrigation engineering.

e) Transportation Engineering

- The development of nation depends on the communication facilities available.
- There are three modes of transportation viz. land, water and air.
- It deals with design, construction and execution of communication routes.
- The different branches of transportation include

Highway engineering - deals with planning and designing of roads.

Railway engineering - deals with planning, building and maintenance of railway

Harbour engineering - deals with harbours Airport engineering - deals with airports

f) Environmental Engineering

- The role is to build a bridge between biology and technology by applying all techniques to the job of cleaning debris.
- It includes water supply engineering and sanitary engineering.
- Planning, purification and supply of water comes under water supply engineering.
- Sanitary engineering deals with planning, treatment and disposal of waste water.

g) Surveying

- It is defined as art of determining relative positions of points on above or beneath the surface of earth by means of direct or indirect measurements of distance, direction and elevation.
- Different instruments used for surveying are chain, compass, level, theodolite, total station etc.

2. INTRODUCTION TO BUILDINGS

- The location of the building has utmost importance in bringing a tranquil atmosphere in a dwelling.
- A properly located site with good foundation soil brings down the cost of construction.
- Natural ventilation and lighting need to be considered.
- Vicinity of other utility centres, transportation and communication facilities govern the selection of a site for residence.

2.1. TYPES OF BUILDINGS

Classification of building as per occupancy

Group A	-	Residential
Group B	-	Educational
Group C	-	Industrial
Group D	-	Assembly
Group E	-	Business
Group F	-	Mercantile
Group G	-	Industrial
Group H	-	Storage
Group J	-	Hazardous

2.2. SELECTION OF SITE FOR BUILDINGS

The various factors are to be considered for the selection of a site for a residential building are

1. The site should be fairly level with good quality of soil
2. The location should be calm but reasonably developed
3. It should be well connected by the roads and other modes of transport.
4. It should have good communication facilities.
5. Electricity, water and sewer lines should be available.
6. It should be away from hazardous industries.
7. Flood prone areas, water logged areas and reclaimed land should be avoided.
8. The site should have good natural ventilation and lighting.
9. The amenities like schools, recreation centres, shopping centres, hospitals should be nearer.
10. Site should have quick drainage properties.
11. It may have regular shape with sufficient frontage
12. The area must be sufficient for present and future development.
13. The places prone to air and water pollution should be avoided.
14. The proper owner ship and other legal matters have to be checked before buying a site.
15. The type of land use recommended at proposed site should be checked with local authorities.

2.3 COMPONENTS OF A BUILDING

Typically, a building has two important components. They

1. **Sub-structure or foundation**

Sub-structure is the portion of the building, below ground level, which transmits the load of super structure to the soil. It is also called as foundation

2. **Super structure**

Super structure is that component of the building which is constructed above the sub-structure.

Components of a building

The various components of super structure are:

a. **Basement:** The part of the building lies between the ground level and the plinth level is known as basement.

b. **Plinth:** The top outer edge of the basement

staircase etc.

The maximum percentage of coverage (i.e., coverage/plot area as percentage) shall not exceed the limits shown in the Table.

6. **Floor Area Ratio (F.A.R.):** The total floor area means total built up a in all floors excluding parking area. The ratio of total floor area on all floors to plot arca is called Floor Area Ratio. (F.A.R.)

Floor Area Ratio. (F.A.R.) =

$$\frac{\textit{Total floor area on all floors}}{\textit{Plot area}}$$

Sl.	Building use / Occupancy	Maximum permissible coverage (percentage of plot area)	Maximum permissible FAR without additional fee
1	Residential A1	65	3
2	Special residential A2	65	2.5
3	Educational B	35	2.5
4	Medical/Hospital C	40	2
5	Assembly D	40	1.5
6	Office/Business E	40	2
7	Mercantile/Commercial F	65	2.5
8	Industrial G1	40	1.5
9	Small industrial G2	60	2.5
10	Storage H	60	2.5
11	Hazardous I (1)	30	1
12	Hazardous I (2)	25	0.7

QUESTIONS

1. Function of a civil engineer
   - A. Investigation & surveying
   - B. Planning & design
   - C. Research and development
   - D. All of these
2. The engineer who develops appropriate combinations of steel, concrete, timber, plastic and new exotic materials
   - A. Structural engineer
   - B. Geotechnical engineer
   - C. Transportation engineer
   - D. None of the above
3. The engineers who analyze the properties of soil and rock that support and affect the behavior of these structures.
   - A. Structural engineer
   - B. Geotechnical engineer
   - C. Transportation engineer
   - D. None of the above
4. Which of the following is the basic need of a human being?
   - A. Sheet
   - B. Shelter
   - C. Huts
   - D. Tree
5. What is another name of dwelling unit?
   - A. Row building
   - B. Residential building

C. Plinth area

D. Livable area

30. The building plan is a section at the level:

A. Ground

B. Basement

C. Roof

D. Sill

31. The number of steps in a flight should not be greater than:

A. 10 nos

B. 12 nos

C. 15 nos

D. 14 nos

32. Pick up the portion not included in plinth area

A. Wall

B. Room

C. Verandah

D. Courtyard

33. Maximum permissible coverage for a assembly building is:

A. 65

B. 40

C. 35

D. 30

34. The livable area is known as:

A. Carpet Area

B. Plinth Area

C. Built up Area

D. Floor Area

35. Which one of the following group D type buildings?

A. Industrial

B. Business

C. Educational

D. Assembly

ANSWER KEY

1. D. All of these

- Functions of civil engineers are
- Investigation
- Surveying
- Planning
- Design
- Execution
- Research and development

2. A. Structural engineer

- Structural engineers develop appropriate combinations of steel, concrete, timber, plastic and new exotic materials.
- They also plan and design, and visit project sites to make site work is done properly.

3. B. Geotechnical engineer

- Geotechnical engineers who analyze the properties of soil and rock that support and affect the behavior of these structures.

4. B. Shelter

The basic need of a human being is shelter.

5. B. Residential building

These are buildings which are used for normal residential purposes and should facilitate activities such as sleeping, living and cooking.

6. A. Group C

Classification of building as per occupancy

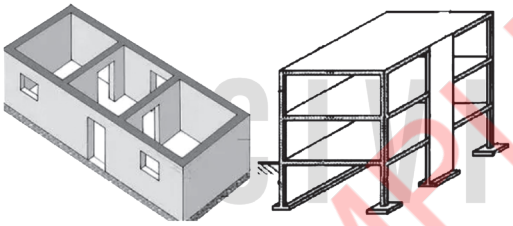
Group A	-	Residential
Group B	-	Educational
Group C	-	Industrial
Group D	-	Assembly
Group E	-	Business
Group F	-	Mercantile
Group G	-	Industrial

with sand, and are plugged at the bottom with concrete.

3.1.5. LOAD BEARING AND FRAMED STRUCTURES

Load bearing structure is probably the oldest and commonest type of structure, and it is the structure in which the loads of the roofs as well as lateral loads such as earthquake, wind etc. are borne by walls, and through walls they are transferred to lower floor and eventually to foundations. It is also known as wall bearing structure.

A framed structure is a structure having the combination of structural components i.e. beam, column and slab connected together to resist the gravity and different lateral loads. These structures are generally used to overcome the large forces, moments developing due to the applied loads. It is also known as beam column structure.



LOAD BEARING STRUCTURE FRAMED STRUCTURE

3.2. BRICK MASONRY

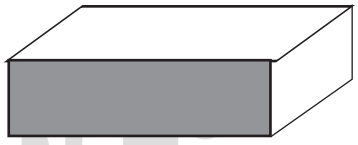
3.2.1. INTRODUCTION

- Brick masonry is made of brick units bonded together with mortar.
- Two essential components of brick masonry are
  a. Bricks
  b. Mortar
- Mortar acts as cementing material and unites the individual brick units together to act as homogenous mass.
- The mortar used in brick masonry may be cement mortar, lime mortar, cement lime mortar, lime surkhi mortar or mud mortar.
- Brick masonry is preferred over other types of masonry due to following,
  1. All the bricks are of uniform size and shape, and hence they can be laid in any definite pattern.
  2. Brick units are light in weight and small in size. Hence, these can be reasons easily handled.
  3. Bricks do not need any dressing.
  4. Stone masonry construction requires highly skilled masons whereas brick masonry can be done by even unskilled masons.

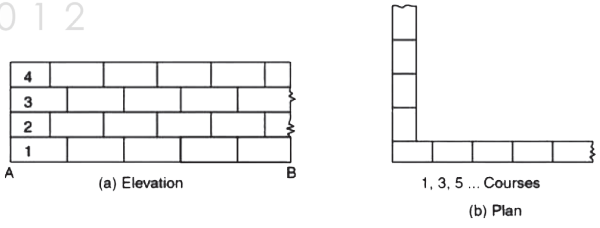
3.2.2. TERMS USED IN BRICK MASONRY

a) Stretcher:

- A brick laid with its length parallel to the direction of a wall is termed as stretcher.

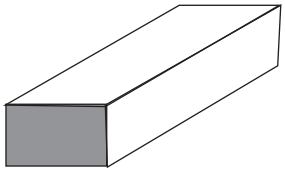


- A course of bricks in which all the bricks are laid as stretchers is known as a stretcher course.

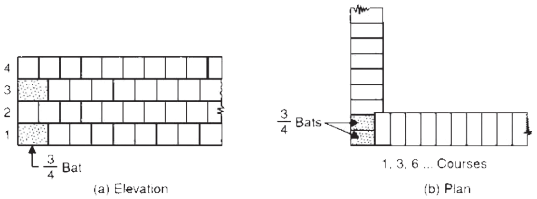


b) Header:

- A brick laid with its length perpendicular to the direction of wall is called as a header.



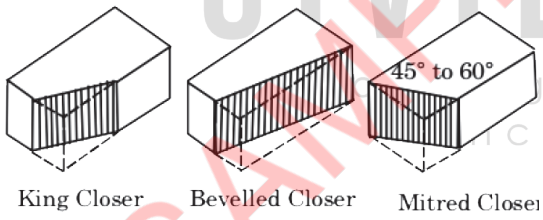
- A course of bricks in which all the bricks are laid as headers is known as header course.



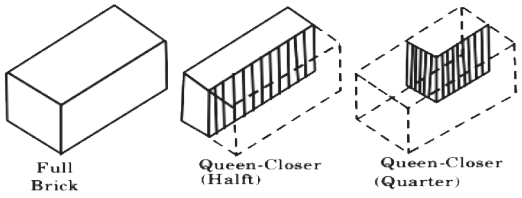
c) Closer:

- It is a portion of brick either cut from a brick or manufactured to the required shape.
- A closer help in preventing the joints of successive courses to come in a vertical line.
- Closers may be of various types,

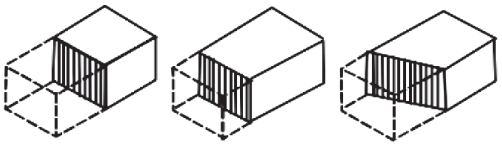
i. King closer: It is the portion of a brick, which is so cut that the width of its ends is half that of a full brick, while the width at the other end is equal to the full width. It is obtained by cutting the triangular piece between t center of one end and the centre of the other end.



ii. Queen closer: It is a portion of a brick obtained by cutting a brick length wise into two portions. Thus, a queen closer is a brick, which is half wide as the full brick.

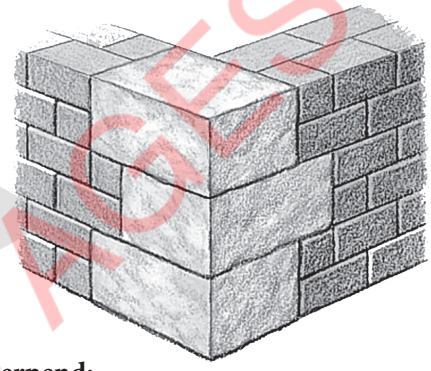


d) Bat: A portion of the brick cut across the width is called bat.



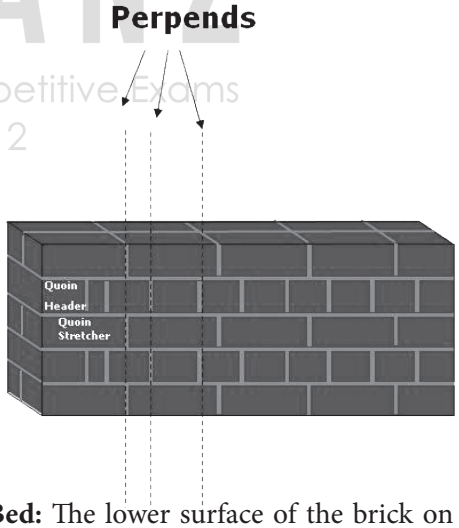
Different forms of brick bat

e) Quoin: It is a corner or the external angle on the face side of a wall.

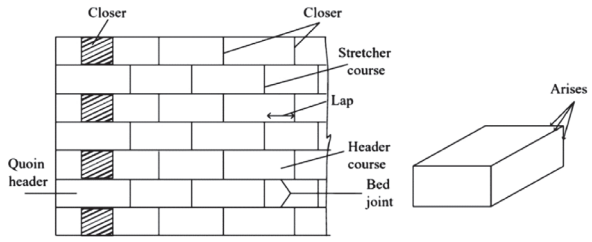


f) Perpend:

A perpend is an imaginary vertical line which includes the vertical joint separating two adjoining bricks.



g) Bed: The lower surface of the brick on which they rest in course is called bed.



h) Lap: It is the horizontal distance between the vertical joints of successive courses of bricks.

3.2.3. BONDS IN BRICK MASONRY

- Method of arranging the bricks in courses so that the individual units are tied together and vertical joints of successive courses do not lie in same vertical line.
- Various types are distinguished by their elevation or face appearance.
- Help in distributing the concentrated loads over a large area.

Rules for bonding

I. The bricks should be of uniform size.

2. The vertical joints in alternative courses should be along same perpend.

3. The amount of lap should be minimum ½ brick along the length of wall and brick across the thickness of wall

4. In alternate courses, the center line of header should coincide with the centre line of stretcher, in the course below or above it.

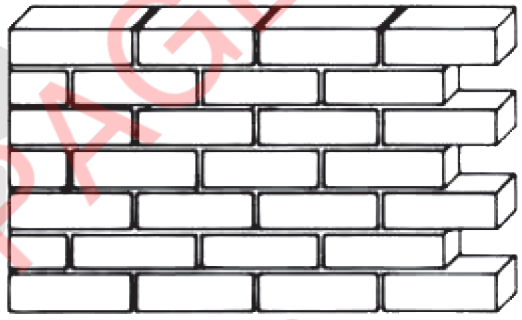
3.2.4. TYPES OF BONDS

Various types of bonds used in brick

1. Stretcher bond
2. Header bond
3. English bond
4. Flemish bond
5. Garden wall bond
6. Raking bond
7. Dutch bond
8. Brick on edge bond
9. English cross bond
10. Dutch bond

1. Stretcher Bond

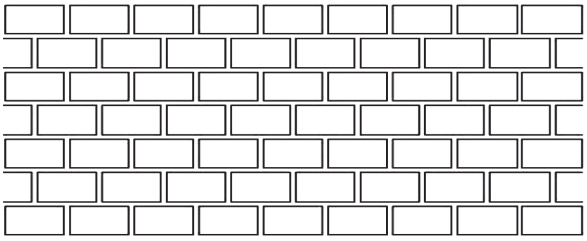
- All the bricks are arranged in the stretcher courses.
- The length of brick is along the length of wall.
- This pattern is used only for those walls which have thickness of half brick.
- The stretcher bond is useful for one brick partition wall.
- This bond is not possible for larger thickness.



Stretcher bond

2. Header Bond

- All bricks are laid as headers on the faces of walls.
- The width of brick is along the direction of wall.
- This pattern is used when the thickness of wall is equal to one brick.
- It does not have strength to transmit pressure in the direction of length of the wall.



3. English Bond

- Most commonly used bond, for all wall

ANSWER KEY

1. C. Steady-state process

The following are some of the most commonly studied thermodynamic processes:

i) Heat does not lose or acquire energy in an adiabatic process.

ii) At a constant enthalpy, the isenthalpic process occurs.

iii) The isobaric process happens when the pressure remains constant.

iv) The isochoric process (also known as isometric/isovolumetric) happens at a constant volume.

v) At a constant temperature, an isothermal process occurs.

vi) Internal energy does not change in a steady-state operation.

vii) Isentropic process: adiabatic reversible process with constant entropy.

2. B. 0K

The temperature of an object on a scale with 0 as absolute zero is known as absolute temperature, also known as thermodynamic temperature. Kelvin and Rankine are absolute temperature scales.

3. D. Positive, negative

The direction of heat transfer is taken from the high-temperature system to the low-temperature system.

4. B. Air standard cycle of SI engine

The Otto cycle is air standard cycle and is used in SI engine.

5. B. $Q = \Delta E + W$

Q-W is the net energy stored in system and is called internal energy of system.

6. A. Diesel cycle, Dual cycle, Otto cycle

7. C. Two constant volume process and two adiabatic process

The sequence of processes in otto cycle is isentropic compression, isochoric heat addition, isentropic expansion and isochoric heat rejection. Therefore an air standard otto cycle consist of two constant volume and two adiabatic process.

8. B. Diesel cycle

Compression ignition engine that uses fuel injection to compressed air for combustion. An air standard diesel cycle is the idealized cycle for the compression ignition engines(diesel engines).

9. B. $1 - (T_4 - T_1)/\gamma(T_3 - T_2)$

$Q_{addition} = m_{cp}(T_3 - T_2)$

$Q_{rejection} = m_{cv}(T_4 - T_1)$

Efficiency of diesel engine $= (Q_1 - Q_2)/Q_1$

Efficiency of diesel engine $= 1 - (T_4 - T_1)/\gamma(T_3 - T_2)$

10. B. Chemical energy

Chemical energy is produce in a fuel due to chemical reaction. This chemical energy is converted into thermal energy by means of a heat engine

11. D. Raising its temperature and doing external work

Addition of heat at constant pressure to a gas results in raising its temperature and doing external work

When you heat a gas, both its vapor pressure and the volume it occupies increase. The individual gas particles become more energetic and the temperature of the gas increases.

12. D. Thermal conductivity

Heat and work are path functions because they depend on how a system changes from initial to final state, hence they are state functions.

Thermal conductivity is mainly a function of the motion of the free electrons therefore property of a material, not a path function.

13. C. Density

Intrinsic properties (also called intensive) are those which are independent of the quantity of matter present. For example, the density of gold is the same no matter how much gold you

PREVIOUS YEAR QUESTION SET - II

LET EXAM PATTERN

Type of Examination	:	Objective Type (Multiple Choice Questions)
No. of questions	:	120 Questions
Apportionment of marks	:	Each Question carry 1mark
Duration of Examination	:	2hrs
Negative marks for wrong	:	No Negative marks
Maximum marks	:	120

SUBJECT WISE WEIGHTAGE

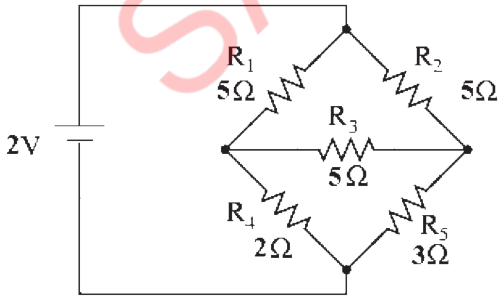
SL. NO.	SUBJECT	WEIGHTAGE
1	Basic Civil and Mechanical Engg	30
2	Basic Electrical and Electronics Engg	30
3	Programming in C	15
4	Engineering Mechanics	15
5	Mathematics	20
6	English	10
	Total Marks	120

1. Three resistors 100Ω, 200Ω and 300Ω are connected in series to a 250V supply. The current in the circuit is:
   A. 0.417 A
   B. 4A
   C. 0.62 A
   D. 0.2 A

2. The resistance of a copper wire is R Ω. The wire is stretched to its double length. The new resistance is:
   A. R Ω
   B. R/2 Ω
   C. 4R Ω
   D. 2R Ω

3. A solenoid of length 1m and diameter 10 cm has 5000 turns. The energy stored in the inductance when a current of 2A flows in the solenoid is:
   A. 0.494 J
   B. 4 J
   C. 5000 J
   D. 25 J

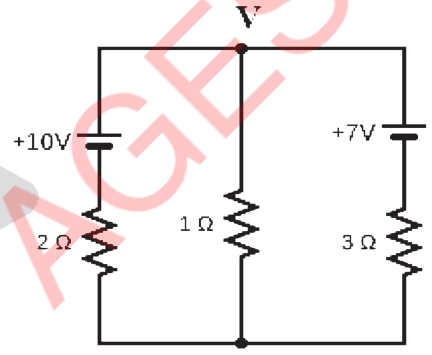
4. Find the current in the circuit



   A. 0.55 A
   B. 0.65 A
   C. 0.67 A
   D. 0.87 A

5. Kirchhoff's laws are valid for ……..
   A. Linear circuits only
   B. Non-linear circuits only
   C. Neither linear nor non-linear circuits
   D. Both linear and non-linear circuits

6. Find the node voltage V



   A. 1V
   B. 2V
   C. 3V
   D. 4V

7. The direction of magnetic lines of force are:
   A. From north pole to south pole
   B. From south pole to north pole
   C. No specific direction
   D. From one end of the magnet to the other

8. Find the coupling coefficient if the mutual inductance is 20H, the inductance of first coil is 2H and the inductance of second coil is 8H.
   A. 5
   B. 20
   C. 2
   D. 8

9. The unit of flux density is:
   A. Tesla

WORKOUT SHEET

1 Ⓐ Ⓑ Ⓒ Ⓓ	31 Ⓐ Ⓑ Ⓒ Ⓓ	61 Ⓐ Ⓑ Ⓒ Ⓓ	91 Ⓐ Ⓑ Ⓒ Ⓓ
2 Ⓐ Ⓑ Ⓒ Ⓓ	32 Ⓐ Ⓑ Ⓒ Ⓓ	62 Ⓐ Ⓑ Ⓒ Ⓓ	92 Ⓐ Ⓑ Ⓒ Ⓓ
3 Ⓐ Ⓑ Ⓒ Ⓓ	33 Ⓐ Ⓑ Ⓒ Ⓓ	63 Ⓐ Ⓑ Ⓒ Ⓓ	93 Ⓐ Ⓑ Ⓒ Ⓓ
4 Ⓐ Ⓑ Ⓒ Ⓓ	34 Ⓐ Ⓑ Ⓒ Ⓓ	64 Ⓐ Ⓑ Ⓒ Ⓓ	94 Ⓐ Ⓑ Ⓒ Ⓓ
5 Ⓐ Ⓑ Ⓒ Ⓓ	35 Ⓐ Ⓑ Ⓒ Ⓓ	65 Ⓐ Ⓑ Ⓒ Ⓓ	95 Ⓐ Ⓑ Ⓒ Ⓓ
6 Ⓐ Ⓑ Ⓒ Ⓓ	36 Ⓐ Ⓑ Ⓒ Ⓓ	66 Ⓐ Ⓑ Ⓒ Ⓓ	96 Ⓐ Ⓑ Ⓒ Ⓓ
7 Ⓐ Ⓑ Ⓒ Ⓓ	37 Ⓐ Ⓑ Ⓒ Ⓓ	67 Ⓐ Ⓑ Ⓒ Ⓓ	97 Ⓐ Ⓑ Ⓒ Ⓓ
8 Ⓐ Ⓑ Ⓒ Ⓓ	38 Ⓐ Ⓑ Ⓒ Ⓓ	68 Ⓐ Ⓑ Ⓒ Ⓓ	98 Ⓐ Ⓑ Ⓒ Ⓓ
9 Ⓐ Ⓑ Ⓒ Ⓓ	39 Ⓐ Ⓑ Ⓒ Ⓓ	69 Ⓐ Ⓑ Ⓒ Ⓓ	99 Ⓐ Ⓑ Ⓒ Ⓓ
10 Ⓐ Ⓑ Ⓒ Ⓓ	40 Ⓐ Ⓑ Ⓒ Ⓓ	70 Ⓐ Ⓑ Ⓒ Ⓓ	100 Ⓐ Ⓑ Ⓒ Ⓓ
11 Ⓐ Ⓑ Ⓒ Ⓓ	41 Ⓐ Ⓑ Ⓒ Ⓓ	71 Ⓐ Ⓑ Ⓒ Ⓓ	101 Ⓐ Ⓑ Ⓒ Ⓓ
12 Ⓐ Ⓑ Ⓒ Ⓓ	42 Ⓐ Ⓑ Ⓒ Ⓓ	72 Ⓐ Ⓑ Ⓒ Ⓓ	102 Ⓐ Ⓑ Ⓒ Ⓓ
13 Ⓐ Ⓑ Ⓒ Ⓓ	43 Ⓐ Ⓑ Ⓒ Ⓓ	73 Ⓐ Ⓑ Ⓒ Ⓓ	103 Ⓐ Ⓑ Ⓒ Ⓓ
14 Ⓐ Ⓑ Ⓒ Ⓓ	44 Ⓐ Ⓑ Ⓒ Ⓓ	74 Ⓐ Ⓑ Ⓒ Ⓓ	104 Ⓐ Ⓑ Ⓒ Ⓓ
15 Ⓐ Ⓑ Ⓒ Ⓓ	45 Ⓐ Ⓑ Ⓒ Ⓓ	75 Ⓐ Ⓑ Ⓒ Ⓓ	105 Ⓐ Ⓑ Ⓒ Ⓓ
16 Ⓐ Ⓑ Ⓒ Ⓓ	46 Ⓐ Ⓑ Ⓒ Ⓓ	76 Ⓐ Ⓑ Ⓒ Ⓓ	106 Ⓐ Ⓑ Ⓒ Ⓓ
17 Ⓐ Ⓑ Ⓒ Ⓓ	47 Ⓐ Ⓑ Ⓒ Ⓓ	77 Ⓐ Ⓑ Ⓒ Ⓓ	107 Ⓐ Ⓑ Ⓒ Ⓓ
18 Ⓐ Ⓑ Ⓒ Ⓓ	48 Ⓐ Ⓑ Ⓒ Ⓓ	78 Ⓐ Ⓑ Ⓒ Ⓓ	108 Ⓐ Ⓑ Ⓒ Ⓓ
19 Ⓐ Ⓑ Ⓒ Ⓓ	49 Ⓐ Ⓑ Ⓒ Ⓓ	79 Ⓐ Ⓑ Ⓒ Ⓓ	109 Ⓐ Ⓑ Ⓒ Ⓓ
20 Ⓐ Ⓑ Ⓒ Ⓓ	50 Ⓐ Ⓑ Ⓒ Ⓓ	80 Ⓐ Ⓑ Ⓒ Ⓓ	110 Ⓐ Ⓑ Ⓒ Ⓓ
21 Ⓐ Ⓑ Ⓒ Ⓓ	51 Ⓐ Ⓑ Ⓒ Ⓓ	81 Ⓐ Ⓑ Ⓒ Ⓓ	111 Ⓐ Ⓑ Ⓒ Ⓓ
22 Ⓐ Ⓑ Ⓒ Ⓓ	52 Ⓐ Ⓑ Ⓒ Ⓓ	82 Ⓐ Ⓑ Ⓒ Ⓓ	112 Ⓐ Ⓑ Ⓒ Ⓓ
23 Ⓐ Ⓑ Ⓒ Ⓓ	53 Ⓐ Ⓑ Ⓒ Ⓓ	83 Ⓐ Ⓑ Ⓒ Ⓓ	113 Ⓐ Ⓑ Ⓒ Ⓓ
24 Ⓐ Ⓑ Ⓒ Ⓓ	54 Ⓐ Ⓑ Ⓒ Ⓓ	84 Ⓐ Ⓑ Ⓒ Ⓓ	114 Ⓐ Ⓑ Ⓒ Ⓓ
25 Ⓐ Ⓑ Ⓒ Ⓓ	55 Ⓐ Ⓑ Ⓒ Ⓓ	85 Ⓐ Ⓑ Ⓒ Ⓓ	115 Ⓐ Ⓑ Ⓒ Ⓓ
26 Ⓐ Ⓑ Ⓒ Ⓓ	56 Ⓐ Ⓑ Ⓒ Ⓓ	86 Ⓐ Ⓑ Ⓒ Ⓓ	116 Ⓐ Ⓑ Ⓒ Ⓓ
27 Ⓐ Ⓑ Ⓒ Ⓓ	57 Ⓐ Ⓑ Ⓒ Ⓓ	87 Ⓐ Ⓑ Ⓒ Ⓓ	117 Ⓐ Ⓑ Ⓒ Ⓓ
28 Ⓐ Ⓑ Ⓒ Ⓓ	58 Ⓐ Ⓑ Ⓒ Ⓓ	88 Ⓐ Ⓑ Ⓒ Ⓓ	118 Ⓐ Ⓑ Ⓒ Ⓓ
29 Ⓐ Ⓑ Ⓒ Ⓓ	59 Ⓐ Ⓑ Ⓒ Ⓓ	89 Ⓐ Ⓑ Ⓒ Ⓓ	119 Ⓐ Ⓑ Ⓒ Ⓓ
30 Ⓐ Ⓑ Ⓒ Ⓓ	60 Ⓐ Ⓑ Ⓒ Ⓓ	90 Ⓐ Ⓑ Ⓒ Ⓓ	120 Ⓐ Ⓑ Ⓒ Ⓓ

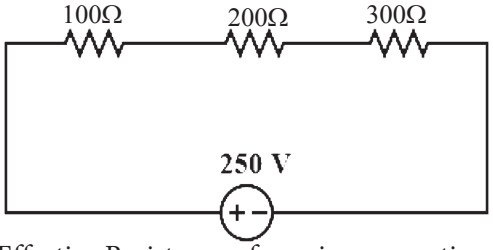
Number of Right Answers : .....

Number of Wrong Answers : .....

Marks Scored	Total Marks

SOLUTION WITH EXPLANATION

1. Answer: A. 0.417 A



Effective Resistance of a series connection,

R_{eff} = 100 + 200 + 300 = 600 Ω

Given voltage, V = 250 V

By Ohm's Law, V = IR

Therefore, I = V/R = V/R_{eff} = 250/600

= 0.41666 = 0.417 A

2. Answer: C. 4R Ω

$$\text{Resistance, } R = \rho \frac{l}{A}$$

Given, the resistance of a copper wire is R Ω

When the wire is stretched to its double length, l' = 2l, then, then its area will decrease automatically. But the volume of the wire will be the same.

∴ The volume of original wire = volume of new wire

⇒ A x l = A' x l'

⇒ A x l = A' x 2l

⇒ A' = A/2

The resistance of the wire in 1st case is R Ω

The resistance of the wire in 2nd case,

$R' = \rho \frac{2l}{\frac{A}{2}} = 4R\ \Omega$

3. Answer: A. 0.494 J

Energy stored in the inductance, $E = \frac{LI^2}{2}$

Here, L = Inductance, I = Current

Self-inductance, $L = \frac{\mu_0 \mu_r (N)^2 A}{l}$

Here, A = Area, N = Number of turns, l = Length of coil

Given, number of turns of a coil N = 5000, length l = 1 m, diameter d = 10 cm = 10 × 10-2m

Then, Area $A = \frac{\pi d^2}{4} = \pi \frac{(10 \times 10^{-2})^2}{4} = 0.00785$ m^2

We have $\mu_0 = 4\pi \times 10^{-7}$, $\mu_r = 1$, So,

Self-inductance,

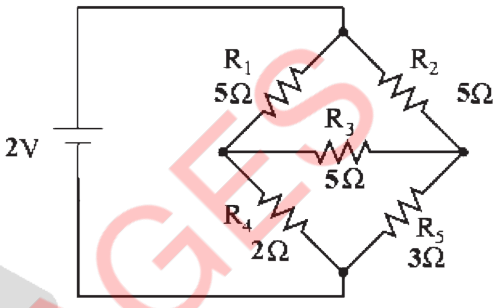
$L = \frac{4\pi \times 10^{-7} \times 1 \times (5000)^2 \times 0.00785)}{1} = 0.2466$ H

Given, current I = 2 A

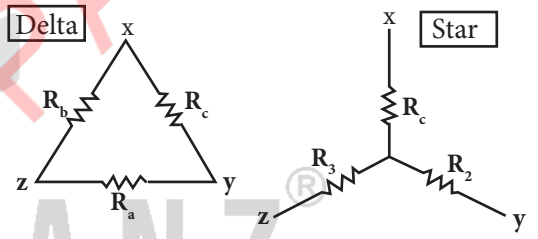
Energy stored in the inductance,

$E = \frac{0.2466 \times 2^2}{2} = 0.494$ J

4. Answer: A. 0.55 A



Delta-Star transformation:

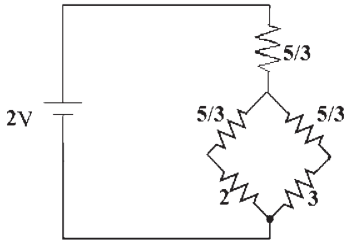


$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1} \qquad R_1 = \frac{R_bR_c}{R_a + R_b + R_c}$$

$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2} \qquad R_2 = \frac{R_aR_c}{R_a + R_b + R_c}$$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3} \qquad R_3 = \frac{R_aR_b}{R_a + R_b + R_c}$$

So, the circuit will be:



The resistors $\frac{5}{3}$ ohms and 2 ohms are in series: $\frac{5}{3} + 2 = \frac{11}{3}\Omega$

We know that Quality factor is equal to the resonant frequency divided by the bandwidth.

$$Q = f_{res}/\text{Bandwidth} = 50/5 = 10$$

14. Answer: B. 90 degrees

In a series RLC circuit, voltage across capacitor lag the current by 90° and voltage across resistor is in phase with current so, the phase difference between the voltage across the capacitor and the voltage across the resistor is 90°.

15. Answer: B. 0.5

Sl.	Power factor [pf] (Phase angle)	Watterme-ter read-ings (W)		Remarks
		W_1	W_2	
1.	pf = unity [1,0] ($\phi = 0^o$)	+ve	+ve	$W_1 = W_2$
2.	$0.5 < pf < 1.0$ ($60^o > \phi > 0^o$)	+ve	+ve	$W_1 > W_2$
3.	pf = 0.5 ($\phi = 60^o$)	+ve	zero (0,0)	Total power = W_1
4.	$0.0 < pf < 0.5$ ($90^o > \phi > 60^o$)	+ve	-ve	$[W_1] > [W_2]$ (Total power = +ve)
5.	pf = zero [0, 0] ($\phi = 90^o$)	+ve	-ve	$[W_1] > [W_2]$ (Total power = zero (0,0))

16. Answer: A. $5i + 2j + 7k$

$\vec{F_1} = 2i - j + k$

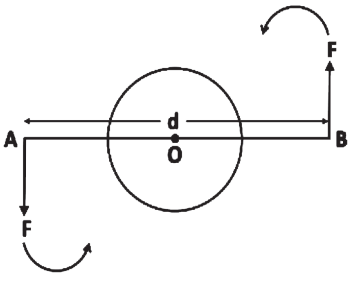
$\vec{F_2} = i + j + 2k$

$\vec{F_3} = 2i + 2j + 4k$

$\vec{R_r} = (2+1+2)i + (-1+1+2)j + (1+2+4)k$

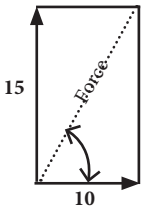
$= 5i + 2j + 7k$

17. Answer: C. Couple



- A couple is a pair of forces, equal in magnitude, oppositely directed, and displaced by perpendicular distance or moment.
- The simplest kind of couple consists of two equal and opposite forces whose lines of action do not coincide.

18. Answer: B. 21.79 N

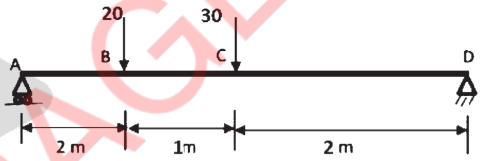


Resultant Force $= \sqrt{(F_1^2 + F_2^2 + 2F_1F_2 \text{ Cos, })}$

$= \sqrt{(100 + 225 + 2 \times 10 \times 15 \text{ Cos } 60)}$

$= 21.79$ N

19. Answer: C. 24 kN



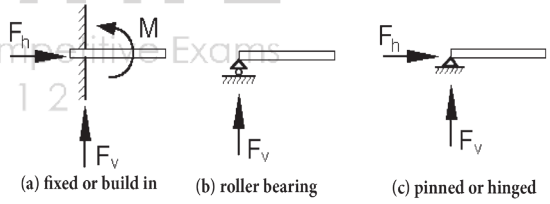
$5R_D = 30 \times 3 + 20 \times 2$

$R_D = 26$ kN

$R_A + R_D = 30+50$

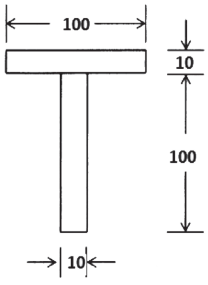
$R_A = 24$kN

20. Answer: D. 2



21. Answer: A. 7.37 kN

22. Answer: A 77.5 kN



Centre of gravity from bottom =

$y = (A_1X_1 + A_2X_2)/(A_1 + A_2)$