Ph.D. Entrance Test - 2019-20 (Phase-II)

Part – A: Research Methodology

Syllabus:


Reference Books:

1. Dipankar Deb, Rajeeb Dey, Valentina E. Balas, Engineering Research Methodology, A Practical Insight for Researchers, Springer Publications, 2019

Part- B: Civil Engineering

Syllabus:

Section 1: Structural Engineering

**Engineering Mechanics:** System of forces, free-body diagrams, equilibrium equations; Internal forces in structures; Friction and its applications; Kinematics of point mass and rigid body; Centre of mass; Euler’s equations of motion; Impulse-momentum; Energy methods; Principles of virtual work.

**Solid Mechanics:** Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Theories of failures; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, buckling of column, combined and direct bending stresses.
**Structural Analysis:** Statically determinate and indeterminate structures by force/energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.

**Construction Materials and Management:** Construction Materials: Structural steel - composition, material properties and behaviour; Concrete - constituents, mix design, short-term and long-term properties; Bricks and mortar; Timber; Bitumen. Construction Management: Types of construction projects; Tendering and construction contracts; Rate analysis and standard specifications; Cost estimation; Project planning and network analysis - PERT and CPM.

**Concrete Structures:** Working stress, Limit state and Ultimate load design concepts; Design of beams, slabs, columns; Bond and development length; Prestressed concrete; Analysis of beam sections at transfer and service loads. Steel Structures: Working stress and Limit state design concepts; Design of tension and compression members, beams and beam-columns, column bases; Connections - simple and eccentric, beam-column connections, plate girders and trusses; Plastic analysis of beams and frames.

**Section 2: Geotechnical Engineering**

**Soil Mechanics:** Origin of soils, soil structure and fabric; Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Darcy’s law; Seepage through soils - two-dimensional flow, flow nets, uplift pressure, piping; Principle of effective stress, capillarity, seepage force and quicksand condition; Compaction in laboratory and field conditions; One-dimensional consolidation, time rate of consolidation; Mohr’s circle, stress paths, effective and total shear strength parameters, characteristics of clays and sand.

**Foundation Engineering:** Sub-surface investigations - scope, drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes - finite and infinite slopes, method of slices and Bishop’s method; Stress distribution in soils - Boussinesq’s and Westergaard’s theories, pressure bulbs; Shallow foundations - Terzaghi’s and Meyerhoff’s bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations - types of piles, dynamic and static formulae, load capacity of piles in sands and clays, pile load test, negative skin friction.

**Section 3: Water Resources Engineering**

**Fluid Mechanics:** Properties of fluids, fluid statics; Continuity, momentum, energy and corresponding equations; Potential flow, applications of momentum and energy equations; Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth.
**Hydraulics:** Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Kinematics of flow, velocity triangles; Basics of hydraulic machines, specific speed of pumps and turbines; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, slope profile, hydraulic jump, uniform flow and gradually varied flow.

**Hydrology:** Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, flood estimation and routing, reservoir capacity, reservoir and channel routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy’s law.

**Irrigation:** Duty, delta, estimation of evapo-transpiration; Crop water requirements; Design of lined and unlined canals, head works, gravity dams and spillways; Design of weirs on permeable foundation; Types of irrigation systems, irrigation methods; Water logging and drainage; Canal regulatory works, cross-drainage structures, outlets and escapes.

**Section 4: Environmental Engineering**

**Water and Waste Water:** Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment. Unit operations and unit processes of domestic wastewater, sludge disposal.

**Air Pollution:** Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

**Municipal Solid Wastes:** Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).

**Noise Pollution:** Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

**Section 5: Transportation Engineering**

**Transportation Infrastructure:** Highway alignment and engineering surveys; Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments; Geometric design of railway track; Airport runway length, taxiway and exit taxiway design.

**Highway Pavements:** Highway materials - desirable properties and quality control tests; Design of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible pavement using IRC: 37-2012; Design of rigid pavements using IRC: 58-2011; Distresses in concrete pavements.
Traffic Engineering: Traffic studies on flow, speed, travel time - delay and O-D study, PCU, peak hour factor, parking study, accident study and analysis, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Control devices, signal design by Webster’s method; Types of intersections and channelization; Highway capacity and level of service of rural highways and urban roads.

Section 6: Geomatics Engineering

Principles of surveying; Errors and their adjustment; Maps - scale, coordinate system; Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Horizontal and vertical curves. Photogrammetry - scale, flying height; Remote sensing - basics, platform and sensors, visual image interpretation; Basics of Geographical information system (GIS) and Geographical Positioning system (GPS).

Ph.D. Entrance Test - 2019-20 (Phase-II)

Model-Question paper

Duration: 2hours Max Marks 70

Part – A: Research Methodology

Section - A contains: 25 questions × 1 mark = 25 Marks
Section- B contains: 15 questions × 2 marks = 30 Marks
Section-C contains: 5 questions × 3 marks = 15 Marks

Section-A
Answer the following each question carries 1 Mark
25 questions × 1 mark = 25 Marks

1. Essence of both basic and applied research lies in
   a) Market orientation  b) scientific method
   c) Performance monitoring research d) costing methods

2. Which of the following is the first step in starting the research process?
   a) Searching sources of information to locate problem.  b) Survey of related literature
   c) Identification of problem d) Searching for solutions to the problem

3. Research involves all the following except
   a) Promotion  b) validation  c) Control d) Testing

4. Statement of research problem is preceded by
   a) Objectives  b) Introduction  c) Review of literature d) Methodology
5. The following are the features of a good research study except
   a) Should be replicable  b) Should be systematic and objective
   c) Should be completed in 6 months  d) Should be ethical and unbiased

6. Applied research is directed towards
   a) Problem solving  b) Action oriented research
   b) Real time problems  d) All of the above

7. The primary objective of ------------ is to provide insights into and an understanding of the problem confronting the researcher
   a) Exploratory research  b) Conclusive research
   c) Casual research  d) Descriptive research

8. Qualitative research is
   a) is essentially same as the quantitative research
   b) Employs rigorous mathematical analysis
   c) is subjective in nature  d) is objective in nature

9. In compare to the primary data, secondary data can be collected
   a) Rapidly and easily  b) At a relatively low cost
   c) In a short time with less effort  d) All of the above

10. Which of the following gives the measure of the consistency of data?
    a) Mean  b) Standard deviation  c) Mode  d) Median

11. Descriptive research is conducted for all the following reasons except
    a) To describe the characteristics of the relevant groups, such as consumers, company personnel, organizations or territories
    b) To determine the occurrence of study variables
    c) To understand which variables are the cause and which variables are the effect of a phenomenon
    d) To determine the perceptions of construction and their features

12. The practice of someone’s work/idea/paper as one’s without proper acknowledgement is termed as
    a) Citation  b) plagiarism  c) Referencing  d) none of the above

13. In the process of conducting research ‘Formulation of Hypothesis” is followed by
    a) Statement of Objectives  b) Analysis of Data
    c) Selection of Research Tools  d) Collection of Data

14. A research paper is a brief report of research work based on
    a) Primary Data only  b) Secondary Data only
    c) Both Primary and Secondary Data  d) None of the above
15. Conference proceedings are considered as.................documents.
   a) Conventional    b) Primary    c) Secondary    d) Tertiary

16. Which of the following is not a “Graphic representation” ?
   a) Pie Chart    b) Bar Chart    c) Table    d) Histogram

17. One of the following search engine is exclusively meant for scientific information :
   a) Google    b) Yahoo    c) SCIRUS    d) Altavista

18. What is full form of IPR
   a) Intellectual property rights    b) Intelligent property right
   c) Intellectual property right    d) Intelligent property rotation

   a) Interchange of data between two devices    b) Interchange of data between two computers
   c) Linkage between two computers    d) Linkage between two devices

20. Questionnaire is
   a) Research method    b) Measurement technique
   c) Tool for data collection    d) Data analysis technique

21. A Research Report is a formal statement of
   a) Research process    c) Data collection    b) Research Problem    d) Data Editing

22. A short summary of technical report is called
   a) Article    b) Research Abstract    c) Publication    d) Guide

23. Ethical Neutrality is a feature of
   a) Deduction    b) Scientific method    c) Observation    d) experience

24. Scientific method is committed to .................
   a) Objectivity    b) Ethics    c) Proposition    d) Neutrality

25. Research method is a part of .................
   a) Problem    b) Experiment    c) Research Techniques    d) Research Methodology
Section-B
Answer the following each question carries 2 Marks
15 questions × 2 marks= 30 Marks

26. Before searching you should define the timeframe of your search. Why?
   a) So you don't find the library busy   b) So you find the most articles
   c) So you work when you are most efficient   d) So you do not incur unnecessary costs

27. Why is it important for a researcher to review the literature?
   a) Because it is traditional   b) Because it will find if anyone has done the work before
   c) Because it identifies like-minded researchers   d) Because it shows time has been spent on the subject

28. The literature review will examine:
   a) all aspects of a topic   b) only facts
   c) only one side of the main argument   d) only opinions

29. Writing your research objectives clearly helps to
   a) Define the focus of your study   b) Clearly identify variables to be measured
   c) Indicate the various steps to be involved   d) Establish the limits of the study
   e) All of the above

30. The starting point for a literature search is
   a) tertiary data   b) secondary data   c) primary data   d) some other data

31. Researchers need to be cautious of some material, particularly material found online. Why?
   a) It has been used before   b) The quality is unknown
   c) The author’s name often does not appear   d) It is too recent

32. What do you mean by citation
   a) A citation allows authors to provide the source of any quotations, ideas, and information on the copyrighted works of other authors
   b) A citation allows authors to provide the source of any quotations, ideas, and information on the copyrighted works of own work
   c) Citation is not typically related to copy right works
   d) none of the above

33. When you discover that an author has, (1) cited another author (2) it is good practice to:
   a) not to use the work   b) use the work and attribute it to author 1
   c) use the work and attribute it to author 2   d) locate and read the original, then attribute it to author 2
34. What are the important things when giving a presentation
   a) Introduce yourself by name    b) Slow down when you are speaking
   c) Make eye contact with the audience d) Ask for questions from the audience at the conclusion of presentation e) All of the above

35. The objective of the communication is
   a) Specific    b) Measurable    c) Attainable
   d) Results – oriented and Time-limited e) All of the above

36. A side bar is used to
   a) Useful way of physically framing the text and giving shape to the document.
   b) Highly necessary
c) Used to provide extra information such as organization, or publication; copyright, contact information
   d) both a& b is correct e) both a&c is correct

37. Which is the major disadvantage of using peer-reviewed journals in literature reviews?
   a) The information is too recent    b) Humans control the quality
   c) Subscription fees are high    d) Information could be as old as four years

38. Which of these will NOT help you to decide whether a publication is reputable?
   a) Advertising inside    b) Citation rate
   c) Audience    d) Importance to peers

39. When you cite Internet resources, you do not need to find
   a) date created    b) date of birth of the author
   c) date last updated    d) date of access

40. Which of these is the most efficient way to locate relevant journals?
   a) Searching using tertiary sources    b) Browsing the shelves in the library
   c) Browsing in a newsagents    d) Following up references in articles

41. What do you think might happen if you started a research project, but hadn’t written any clear research objectives?
   a) Confusion about the limits of study    b) Collection of data is unlimited
c) identify barriers and concerns   d) only a is correct e) both a &b is correct

42. Surveying the literature involves
   a) Narrow the problem itself    b) identify the gaps
c) limited information about the existing theories    d) b is correct e) both a& b is correct
43. The purpose of attribution is
a) similar to citation  b) not similar to citation   c) Used to quote (or paraphrase) all or a portion of an openly licensed work   d) both a & c   e) none of the above

44. Who is responsible for plagiarism?
a) Lecturers and supervisors  b) The participant    c) Institution  
 d) The researcher  e) All of the above

45. How do you prepare for presentation?
a) Writing main argument or conclusion  b) Writing the main points as headings 
 c) Timing the presentation & discuss the main issue by clear opening and closing line remarks  d) all of the above  e) only a & b

**Part B: Civil Engineering**

**Section - A contains**
: 25 questions × 1 mark = 25 Marks

**Section - B contains**
: 15 questions × 2 marks = 30 Marks

**Section - C contains**
: 5 questions × 3 marks = 15 Marks

**Section - A**

Answer the following each question carries 1 Mark
25 questions × 1 mark = 25 Marks

1. The Star and Grid pattern of road network was adopted in
   (a) Nagpur Road Plan    (b) Luck now Road Plan
   (c) Bombay Road Plan    (d) Delhi Road Plan

2. The value of lateral friction or side friction used in the design of horizontal curve as per India Roads Congress guidelines is
   (a) 0.40    (b) 0.35     (c) 0.24     (d) 0.15 2

3. Road roughness is measured using
   a) Benkelman beam    b) Bump integrator
   c) Dynamic cone penetrometer    d) Falling weight deflectometer

4. Camber on highway pavement is provided to care of
   a) Centrifugal force    b) Drainage    c) Sight distance    d) Off-tracing

5. The reaction time for calculating SSD may be assumed as
   a) 5 sec    b) 2.5 sec    c) 0.5 sec    d) 10.0 sec

6. The average quantity of water (in lpcd) required for domestic purposes according to IS code is
   a)100    b)120    c)70    d) 135
7. Which method is used to measure the color of water?
   a) Gravimetric  b) Chromatography  c) Tintometer  d) Hydrometer analysis

8. Which of the following represents the physical characteristics of water?
   a) Chlorides  b) BOD  c) Turbidity  d) COD

9. Which of the following is the final stage in the sludge treatment process?
   a) Digestion  b) Dewatering  c) Drying  d) Thickening

10. Which of the following is known as Shut off valve?
    a) Air relief valve  b) Sluice valve  c) Pressure relief valve  d) Altitude valve

11. If the porosity of the sample is 20%, the voids ratio is
    a) 0.2  b) 1  c) 0.8  d) 0.75

12. In a compaction test, as the compaction effort is increased, OMC will
    a) decrease  b) remains same  c) increases  d) increase and then decrease

13. Vane tester is normally used for finding in situ shear strength
    a) soft clay  b) sand  c) stiff clays  d) gravel

14. Principle involved in the relationship between submerged unit weight and saturated
    weight of a soil is based on
    a) Equilibrium of floating bodies  b) Archimede’s principle
    c) Stoke’s law  d) darcy’s law

15. A soil sample has a void ratio of 0.5 and its porosity will be closest to
    a) 50%  b) 66%  c) 100%  d) 30%

16. Cavitation is caused by
    a) high velocity  b) low pressure  c) high pressure  d) high temperature

17. If, for a fluid in motion, pressure at a point is same in all directions then the fluid is
    a) a real fluid  b) a newtonian fluid  c) an ideal fluid  d) a non-newtonian fluid

18. An isohyet is a line joining points of
    a) equal temperature  b) equal humidity  c) equal rainfall depth  d) equal evaporation
19. A sprinkler irrigation system is suitable when
   a) deep slope land       b) soil with low permeability
   c) water table is low    d) crops with deep roots

20. The ratio of actual evapo-transpiration to potential evapo-transpiration is in the range
   a) 0-0.4       b) 0.6-0.9       c) 0-1.0       d) 1-2

21. The number of independent elastic constants for a linear elastic isotropic and homogeneous material is
   a) 1       b) 2       c) 3       d) 4

22. A cantilever beam curved in plan and subjected to lateral loads will develop at any section
   a) Bending Moment & Shear Force       b) bending moment & twisting moment
   c) twisting and shear force       d) BM , SF & Twisting moment

23. The first moment of area about the axis of bending for a beam cross-section is
   a) Moment of Inertia       b) section modulus       c) shape factor       d) polar moment of inertia

24. Poisson’s ratio of steel is __________
   a) 0.1       b) 1.0       c) 0.3       d) 2.0

25. The _________ is used to measure the workability of concrete mixture which is commonly used in the field.
   a) Vee-bee test       b) Slump test       c) Compaction factor       d) Workability test

Section-B
Answer the following each question carries 2 Marks
15 questions × 2 marks= 30 Marks

1. Center of gravity of a solid cone lies on the axis at the height
   A. One-fourth of the total height above base
   B. One-third of the total height above base
   C. One-half of the total height above base
   D. three-eighth of the total height above the base
2. For a beam of triangular cross section, the ratio $\tau_{\text{max}}/\tau_{\text{avg}}$ is
   
   A. $3/2$  \quad B. $4/2$  \quad C. $5/2$  \quad D. None

3. A soil has bulk density 2.30 g/cm$^3$ and water content 15 per cent, the dry density of the sample, is
   
   A. 1.0 g/cm$^3$  \quad B. 1.5 g/cm$^3$  \quad C. 2.0 g/cm$^3$  \quad D. 2.5 g/cm$^3$

4. A 6 m thick clay layer undergoes 90 % consolidation four times faster under two-way drainage as compared to one-way drainage. In an identical clay layer of 15m thickness, two-way drainage will be faster as compared to one-way drainage by
   
   A. 8 times  \quad B. 4 times  \quad C. 2.5 times  \quad D. 2 times

5. What is the correct formula for absolute pressure?
   
   A. $P_{\text{abs}} = P_{\text{atm}} - P_{\text{gauge}}$  \quad B. $P_{\text{abs}} = P_{\text{vacuum}} - P_{\text{atm}}$
   
   C. $P_{\text{abs}} = P_{\text{vacuum}} + P_{\text{atm}}$  \quad D. $P_{\text{abs}} = P_{\text{atm}} + P_{\text{gauge}}$

6. Which one of the following valves is seldom used in water distribution systems because of high head loss characteristics?
   
   A. Butterfly  \quad B. Globe  \quad C. Plug  \quad D. Sluice

7. The Ca$^{++}$ concentration and Mg$^{++}$ concentration of a water sample are 160 mg/lit and 40 mg/lit as their ions respectively. The total hardness of this water sample in terms of CaCO$_3$ in mg/lit is approximately equal to
   
   A. 120  \quad B. 200  \quad C. 267  \quad D. 567

8. The infiltration rate $f$ in a basin under ponding condition is given by $f = 30 + 10e^{-2t}$, where, $f$ is in mm/h and $t$ is time in hour. Total depth of infiltration (in mm, up to one decimal place) during the last 20 minutes of a storm of 30 minutes duration is
   
   A. Range 11-12mm  \quad B. Range 50-60mm  \quad C. Range 100-110mm  \quad D. Range 1-2mm
9. A closed tank contains 0.5 m thick layer of mercury (specific gravity = 13.6) at the bottom. A 2.0 m thick layer of water lies above the mercury layer. A 3.0 m thick layer of oil (specific gravity = 0.6) lies above the water layer. The space above the oil layer contains air under pressure. The gauge pressure at the bottom of the tank is 196.2 kN/m². The density of water is 1000 kg/m³ and the acceleration due to gravity is 9.81 m/s². The value of pressure in the air space is
   A. 92.214 kN/m²       B. 95.644 kN/m²
   C. 98.922 kN/m²       D. 99.321 kN/m²

10. A metal bar of length 100mm is inserted between two rigid supports and its temperature is increased by 10°C. If the coefficient of thermal expansion is 12 x 10⁻⁶ per °C and the Young’s modulus is 2 x 10⁵ MPa, the stress in the bar is
    A. ZERO       B. 24 MPa
    C. 12 MPa     D. 2400 MPa

11. Some of the structural strength of a clayey material that is lost by remoulding is slowly recovered with time. This property of soils to undergo an isothermal gel-to-soil-to-gel transformation upon agitation and subsequent rest is termed
    a. Isotropy       b. Anisotropy
    c. Thixotropy     d. Allotropy

12. According to Robert E. Horton, the equation of infiltration capacity curve, is
    (where letters carry their usual meanings)
    A. \[ f = f_c \left( \frac{f_o - f_c}{f_c} \right) e^{kt} \]
    B. \[ f = f_t - \left( \frac{f_o - f_c}{f_c} \right) e^{kt} \]
    C. \[ f = f_t + \left( \frac{f_o - f_c}{f_c} \right) e^{kt} \]
    D. \[ f = f + \left( \frac{f_o - f_c}{f_c} \right) e^{kt} \]

13. A pin-jointed plane frame is unstable if
    A. \( (m + r) < 2j \)       B. \( m + r = 2j \)
    C. \( (m + r) > 2j \)       D. None
14. The expression of the recirculation factor $F$ is given by
   a. $F = 1 / (1+0.1 \times (R/I))^2$
   b. $F=(1+R)/(1+0.1(R/I))^2$
   c. $F=(1+I/R)/(1+0.1(R/I))^2$
   d. $F = (1+ R/I) / (1+0.1(R/I))^2$

15. An automobile with projected area 2.6 m² is running on a road with a speed of 120 km per hour. The mass density and the kinematic viscosity of air are 1.2 kg/m³ and $1.5 \times 10^{-5}$ m²/s, respectively. The drag coefficient is 0.30. The drag force on the automobile is
   A. 600N  B. 620N  C. 520N  D. 580N

Section- C

Answer the following each question carries 3 Marks
5 questions × 3 marks = 15 Marks

1. A brass bar, having cross sectional area of 100mm², is subjected to axial force of 50kN. The length of two sections is 100mm and 200mm respectively. What will be the total elongation of bar if $E= 1.05 \times 10^5$ N/mm²?
   A. 1.21mm  B. 2.034 mm  C. 2.31 mm  D. 1.428 mm

2. In falling head permeability test the initial head of 1.0 m dropped to 0.35 in 3 hours, the diameter of the standpipe being 5 mm. The soil specimen was 200 mm long and of 100 mm diameter. The coefficient of the probability of the soil is
   A. $4.86 \times 10^{-5}$ cm/s  B. $4.86 \times 10^{-6}$ cm/s
   C. $4.86 \times 10^{-7}$ cm/s  D. $4.86 \times 10^{-8}$ cm/s

3. The alkalinity and hardness of a water sample are 250 mg/L and 350 mg/L as CaCO₃, respectively. The water has
   A. 350 mg/L carbonate hardness and zero non-carbonate hardness.
   B. 250 mg/L carbonate hardness and zero non-carbonate hardness.
   C. 250 mg/L carbonate hardness and 350 mg/L non-carbonate hardness.
   D. 250 mg/L carbonate hardness and 100 mg/L non-carbonate hardness.

4. The speeds of overtaking and overtaken on a highway are 85 kmph and 70 kmph respectively. Calculate the overtaking sight needed for two way traffic. Assume the acceleration of the overtaking vehicle as 2.5 kmph/sec and speed of vehicle in opposite direction is 85 kmph.
   A. 657 m  B. 768 m
5. For a 2-D flow field, the stream function $\Psi$ is given as $3/2(y^2-x^2)$. The magnitude of discharge occurring between the stream line passing through points (0, 3) and (3, 4) is

A. 6 units  B. 1.5 units  
C. 2 units  D. 3 units