

CIVIL ENGINEERING COLLEGE—MADRAS.

December 1863.

SURVEYING AND LEVELLING.

Time 3 hours—125 Marks.

1. Draw any irregular Six-sided Figure and then show how you would survey it?
(1.)—With chain only.
(2.)—With compass and chain,

and then reduce the Figure geometrically so as to be able to compute its area by a single calculation.

2. In measuring with the chain only you meet with a River which your chain cannot span. Show how you may continue the measurement across the water and how you would fix the position of a small Pagoda in an island in the River.

3. In traversing a Road with a Prismatic Compass—why need bearings be taken at every second station only? Explain your answer by a diagram.

4. What angles can you lay off with facility by means of the 100 ft. chain or tape?

5. State the representative fraction of the following scales:

12 feet to an inch

10 yards do.

4 inches to a mile

and name the scales whose representative Fractions are $\frac{1}{25000}$; $\frac{1}{50000}$; $\frac{1}{100000}$.

6. In a drawing to which no scale is attached, the plan of the slope of a Railway embankment = $1\frac{1}{2}$ inches—its height is marked 60 feet and slope 30° —construct the scale of the Drawing.

7. Explain the principle of the Vernier and give the necessary data for the construction of one to read to 15 seconds on a scale graduated to 10 minutes.

8. What corrections are theoretically necessary in levelling operations?

Do these corrections operate in same direction? and show how they may be practically got rid of.

9. From what distance could you see the light of the Madras Light-house which is 120 feet above the level of the sea, your eye being 12 feet above the same level—allowing the effect of Refraction to be $\frac{1}{8}$ that of Curvature.

10. Fill in the following Level Field Book, and plot the Section to a scale of $\frac{1}{2500}$ for horizontal measurements and a scale of $\frac{1}{250}$ for vertical heights?

Back Sight.	Inter-mediate.	Fore Sight.	Rise.	Fall.	Height above base.	Distance.	Total Distance.	REMARKS.
				Datum.	50			
16.00		0.00				300		B. M. + at head of Tank
13.75		10.38				780		Sluice 3.22 above starting
13.98		9.23				630		Point.
10.67		8.34				800		
8.96		7.10				500		
9.16		6.36				900		
11.50		8.75				475		B. M. ✓ on Sill of Ca- lingula.

11. If B, b, represent the bearing of two consecutive lines in a series, and A the angle on the left between them, show that $b = A + B \pm 180^\circ$.

12. Find the latitudes and departures for distances from 1 to 10, when the bearing is 330° , and from these deduce the Latitude and Departure for distance 2371.72, the bearing being 120° .

13. Given A a, B b, C c, D d, E e, F f, and G g, to be the perpendiculars from the angles of a polygon A. B. C. D. E. F. G., on a meridian line lying without it, and the Cardinal Directions of the lines of the Polygon to be as follows. N. E.—N. W.—N. E.—S. W.—N. W.—S. W.—S. E.; write down the area of the Polygon.

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FIRST DEPARTMENT.

CONSTRUCTION OF ROADS, BRIDGES, &c.

CAPTAIN TULLOCH, R. E.—EXAMINER.

Time 3 hours—200 Marks.

1. Tell me what you know about the construction and maintenance of roads.
2. Tell me what you know about canals and locks.
3. What is the object for using wells for a foundation. Describe the method of sinking them and give me all the knowledge you have on the subject of "well foundations."
4. Describe a bridge and relate all you know on the subject of bridge construction.
5. Tell me all you know about the construction and maintenance of Tanks.

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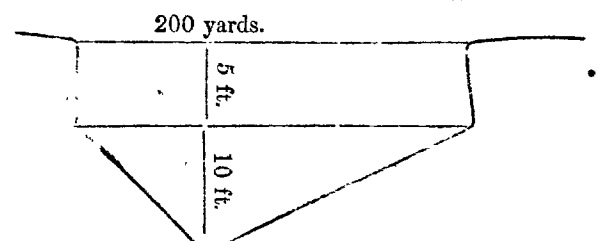
FIRST DEPARTMENT.

HYDRAULICS.

CAPTAIN RYVES, R. E.—EXAMINER.

Time 3 hours—100 Marks.

1. Define specific Gravity—Pressure—Density.
2. State the most important points of difference (1) between a *Fluid* and a *Solid*; (2) between *Air* and *Water*.
3. How is the pressure of Water on a plane surface measured? What would the pressure (lbs : av :) be in the Lower gates of a Lock (150 ft. long by 20 ft. broad) of 8 feet lift. The chamber being full and the depth of water in the tail apron being $3\frac{1}{2}$ feet—the gates being inclined to one another at an angle of 120° ?
4. What causes the discharge of water through a hole or sluice in the side of a Reservoir? and what is the measure of the velocity of the water issuing?
5. Write down Formulae for the quantities of water discharged over a weir; and through a sluice—both with free outfall—and, secondly—for the weir partially submerged, and for the sluice wholly submerged. State distinctly what your letters (for the different dimensions) denote, and whether in inches, feet or yards. Illustrate by a Diagram.
6. The Kistna Anicut is (say) 1,200 yards long, and has 30 under-sluices, each 6 feet wide and averaging $12\frac{1}{2}$ feet high, their floors being 9 feet below the crown of anicut. In a steady fresh with the river surface above the anicut at 27 feet on the register; below it would be $22\frac{1}{2}$ feet, the crown of the anicut itself being 20 feet above the zero of the Register—and the velocity of approach may be assumed at 5,400 yards per hour. Calculate the rate of discharge of the river in such a fresh.
7. How wide at bottom (slopes $1\frac{1}{2}$ to 1) should a channel be to discharge 3,825 cubic feet per minute—the depth of water being $2\frac{1}{2}$ feet, and the fall 8 inches per mile.
8. How deep will the water be in a channel 90 yards wide, with a fall of 5 inches per mile, when the quantity per hour flowing down is 480,000 cubic yards—the side slopes being $1\frac{1}{2}$ to 1. If this channel be divided into two, each having a fall of 1 foot per mile, how wide should they be in order that each should discharge half the above quantity per hour with the same depth of water as in the original main channel?
9. In passing a Boat down through the Lock, (see question 3) if the sluice area of the 2 side culverts be $4\frac{1}{2}$ square feet each:—How long would it take for the water in the chamber to fall to the level of that outside? How much time would be saved by opening the gate when the water surface inside was 6 inches above that outside? And what force would have to be applied at the ends of the balance beams to open the gates—the length of each beam from Quoin Post being 15 feet.
10. The sluices (in the last question) being 2 feet broad—how long would it take 4 men to open them by means of the ordinary rack and pinion worked by a winch, the co-efficient of friction of the rubbing surfaces of the sluice shutters being .42, and a man's power so applied, being taken at 4500 $\frac{\text{lbs. feet}}{\text{min}}$ nett.
11. A jungle stream with a fall of $4\frac{1}{2}$ feet per mile—has the section given in the margin. How much of a 10 feet fresh would be drawn off by a channel and anicut, the crown of the latter being at the 8 feet water line, and the former being 30 yards wide at bottom, with side slopes $1\frac{1}{2}$ to 1, and having its bed taken off at the 3 feet water line, with a slope of $2\frac{1}{2}$ feet per mile—and how wide would the channel have to be to draw off the same quantity were there no anicut.



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FIRST DEPARTMENT.

STATICS, DYNAMICS AND HYDROSTATICS.

Time 3 hours—125 Marks.

- I. Define Weight—Mass—Density, Force—and show how the last is measured (1) in Statics (2) in Dynamics.
- II. If 3 forces represented in magnitude and direction by the 3 sides of a Triangle (taken in order) act upon a point, they will keep it at rest.
- III. Prove that every system of particles has one and only one centre of gravity.
- IV. Let A B C be a triangle, and D the middle point of B C. If the 3 forces represented in magnitude and direction by A B, A C, D A act upon the point A, find the magnitude and direction of the resultant.
- V. An uniform Rod is supported by 2 equal strings attached to its 2 ends and to a fixed point—the rod and strings forming an equilateral triangle. Compare the tension of each of the strings with the weight of the Rod.
- VI. A cylindrical piece of timber 6 feet long—being suspended at distance of 61 inches from one end, required a weight of $5\frac{1}{2}$ cwt. at the other end to keep it parallel to the horizon: what is the diameter of the cylinder?
- VII. A weight of 50 lbs. suspended by a string from a fixed point, is drawn aside by a force acting horizontally, so that the string makes an angle of 30° with the vertical; find the horizontal force acting on the body, and also the tension of the string by which it is suspended.
- VIII. If a line be drawn through the centre of gravity of a triangle, parallel to one of its sides, it will divide the Triangle into 2 parts, having to each other the ratio of 4 : 5.
- IX. Prove that the velocity acquired by a body in falling down a curve in a vertical plane, is that which would have been acquired by the body in falling freely through the same vertical height.
- X. A Pendulum vibrates as often in a minute as it is inches in length—what is its length?
- XI. Distinguish between a liquid and a fluid, and prove that the surface of every fluid at rest is horizontal.
- XII. A Cone whose diameter is 12 and altitude 10 inches, being put into a vessel filled with water with its base upward, was observed to sink to a point at which the area of its section cut parallel to the base was exactly 80 square inches, required the weight of the cone.
- XIII. A vessel is partly filled with water and partly with oil ($sp : gr = \frac{3}{4}$). A body floats with half its bulk in each fluid: Find its $Sp : Gr$: If the oil be drawn off by means of a Syphon, will the body rise or fall in the water?
- XIV. If a glass tube 36 inches long, closed at the top, be sunk perpendicularly in water till its lower or open end be 30 inches below the surface of the water—how high will the water rise within the tube, the mercury in the common Barometer standing at $29\frac{1}{2}$ inches?

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FIRST DEPARTMENT.

DRAWING FROM SPECIFICATION.

CAPTAIN ROGERS, R. E.—EXAMINER.

Time 6 hours—100 Marks.

The building to be on one flat and to comprise one centre room 30×20 with a room on either side 20 feet square. A verandah 10 feet wide in the clear to surround the whole building. Of this verandah the front will be left entirely open and the roof supported by columns and bressumers. The two corner spaces of the back verandah each 10×10 to be enclosed as bath rooms, and the two side verandahs 10×20 to be enclosed as dressing rooms. The foundations of the walls are to be 3 feet thick at bottom diminishing to $2\frac{1}{2}$ at top—and 3 feet in depth throughout—the plinth to be uniformly 2 feet thick and 2 feet high. The main walls of the building to be 16 feet high from top of plinth to upper surface of roof joists and the verandah walls 13 feet high, the thickness to be uniformly $1\frac{1}{2}$ feet.

The roofing to be flat, consisting of the usual Madras terrace work supported on joists (and beams where necessary) of scantling adapted to the spans.

The flooring to be of two courses of bricks laid flat and plastered.

The principal room to have 3 doors in each long wall and 2 doors in each cross wall each 8×5 .

The two side rooms to have 2 windows $5\frac{1}{2}$ by 4 in each long wall and two doors $7\frac{1}{2} \times 4$ leading into the dressing room.

Each dressing room to have 2 external windows 5×4 and one door 7×4 leading into the bath rooms.

The bath rooms to have one external door at the back of the house 7×4 and one external window 5×4 . All the doors and windows to be venetian.

Scale 8 feet to an Inch.

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FIRST DEPARTMENT.

APPLIED MECHANICS.

Time 3 hours—75 Marks.

I. A Roof of 30 feet span and 10 feet rise, consists of couples placed 3 feet apart from centre to centre of 6" $\times$ 8" scantlings. Required the total pressure at the foot of the rafters assuming each square foot of roofing to weigh 20lbs, and each cubic foot of timber 40lbs.

II. These couples rest on masonry walls 10 feet high, weighing 120lbs. per cubic foot—how thick should the walls be?

III. A King Post Truss Roof is substituted for the couples—the Trusses being placed 10 feet apart. Suppose each running foot of roof to weigh 800 lbs., calculate the diameter of a wrought iron Tie-rod sufficient to bear the strain. The rupturing strain of wrought iron being 57,000 lbs. per square inch.

IV. Again, let a masonry segmental arch of 60 and $1\frac{1}{2}$ feet thick be substituted for the Trusses—what thickness should be given to the walls to prevent their being overturned?

V. Determine the scantling of roadway girders of Fir for a Bridge, whose span is 18 feet clear and width of roadway 21 feet. The girders to be placed $1\frac{1}{2}$ feet from centre to centre and to sustain a weight of 300lbs. per square foot—the constant for transverse strength being 400.

VI. Required the thickness of a rectangular Dock-embankment 15 feet high—so that when the water rises to the top, the structure may just be on the point of overturning. (A cubic foot of the material = 140 lbs.)

VII. Required the dimensions of a rectangular revetment 12 feet high, which will just support a bank of earth of the same height, whose natural slope = 30° , the ratio of specific gravities of wall and bank being as 5 : 4.

VIII. Compare with the stability of the revetment in the last example, that of a sloping revetment of equal content—taking the slope at $\frac{1}{2}$ the height.

IX. A sluice gate 10 feet square, is held by a horizontal axis—at what height must this axis be placed that the gate may just open when the water rises to a height of 5 feet above the top of the gate?

X. A bridge 60 feet span and 12 feet width of roadway is supported by 2 Queen Post Truss Girders. The angle of inclination of the Rafters is 30° and the distance between the Queen Posts 20 feet from centre to centre. Find the horizontal thrust and the thrust through each Rafter—and taking the resistance of the wood at 7,000lbs, of which $\frac{1}{10}$ only should be allowed for safety—determine the scantling of the timbers?
(loaded as in Ex. V)

CIVIL ENGINEERING COLLEGE—MADRAS.

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TRIGONOMETRICAL SURVEYING.

Time 3 hours—75 Marks.

1. In a Trigonometrical Survey of a large District, upon what principles would you proceed in the formation of your system of Triangulation.
2. What do you understand by a Base of Verification? what is its object? and if on irregular ground, what corrections must be applied before it is of practical utility?
3. What advantage does the Theodolite possess over a Reflecting Instrument, for obtaining the Horizontal angles between the Trigonometrical points of a survey?
4. Explain clearly and concisely, how you would traverse a Road with Theodolite and chain, through at least 3 stations.
5. If unable to adjust the line of Collimation of a Theodolite, what steps would you take in the course of your observations, to get rid of the error in your angles of altitude?
6. How would you obtain by observation from a church, the correct angles subtended at its spire by your Trigonometrical points?
7. What do you understand by the term "Contour," and explain the method of running Contour lines.
8. Why is it inadmissible to use the direction of the Magnetic needle, as the meridian or Referring Line of a Traverse Survey? Show how it may be used in the field to detect any very important departure, in the course of the Traverse, from the original Referring Line.
9. Find the position of a ship lying off a bay, in the centre of which is a Battery distant $1\frac{1}{2}$ and $2\frac{1}{2}$ miles respectively from points on the headlands 3.8 miles apart, the angles at the ship subtended by the Battery and the headlands being $30^{\circ}45'$ and $56^{\circ}15'$.

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FIRST DEPARTMENT.

TRIGONOMETRY.

Time 3 hours—150 Marks.

J. ANDERSON, Esq., EXAMINER.

(1.) Shew that

$$\sin 3A = 3 \sin A - 4 \sin^3 A.$$

$$\sin A + \sin B = 2 \sin \frac{1}{2}(A + B) \cos \frac{1}{2}(A - B).$$

(2.) Find m in terms of a from the equations $m^2 = 3 \cos^2 \phi + 1$; $\tan \frac{3}{2} \phi = \tan a$.

(3.) In an oblique-angled triangle two angles and a side opposite to one of them are given: shew how the remaining parts of the triangle may be found.

(4.) Express the radius of a circle inscribed in a triangle in terms of the sides of the triangle.

(5.) What is meant by the "logarithm of a number to a given base?" How is the number corresponding to a logarithm found?

(6.) One side of a right-angled triangle is half the hypotenuse, and the perpendicular from the right angle on the hypotenuse is 60 feet: find the perimeter.

(7.) The perimeter of an isosceles triangle is 50 yards, and the vertical angle is 120° : find the area.

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FIRST DEPARTMENT.

MATERIALS AND CONSTRUCTION.

Time 3 hours—100 Marks.

1. What is the composition of the best brick-earth—and state the different processes employed in the manufacture of bricks in this country?
2. State the dimensions of the ordinary wall bricks used in Public Works—and mention any reason in favor of bricks being of fixed dimensions.
3. In what chemical condition is lime usually found in nature, and state how it is rendered fit for making mortar—describe each step of the process.
4. Distinguish between common and Hydraulic lime—also between Concrete and Béton—and show how an artificial hydraulic lime may be obtained.
5. Define the following terms in masonry, viz: Course—Bond—Bed—Quoin—Coping—Facing—Backing—Filling—Header—Stretcher—also distinguish between Ashlar and Rubble stone and state to what description of work each is most suitable.
6. Describe the method of constructing a Terrace Roof in this Presidency—and how you would repair a crack in such a roof.
7. Sketch a King Post Truss for a Roof 30 feet span, and 10 feet rise; name the various timbers and explain clearly the use of each. Describe how the roof is carried on above the trusses, and what distance one truss is from another.
8. What do you mean by scarfing timbers? Draw a sketch of a good scarf for a tie beam and state what beams might be scarfed and what *should not* be scarfed in a roof.
9. Define the terms Intrados—Extrados—Cutwater—Springing—Crown—Haunches—Spandrels and Blocking Course—and state the different circumstances which regulate the shape of the arches of a Bridge.
10. Mention the various modes of building brick arches and show how the thick joints at the back are got rid of when rectangular bricks are used.
11. Sketch some common centres for Bridges as adopted in this country and also that known as Capt. Best's pattern—and state the advantages of the latter method!
12. If a teak-beam is 18 feet between supports, 9 inches deep and 5"·4 broad, with the ends fixed; at what point in its length may a weight of 10,000 lbs. be placed with safety. (Breaking weight of teak = 950 lbs.)

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FIRST DEPARTMENT.

MENSURATION.

CAPTAIN ROGERS, R. E.—EXAMINER.

Time 3 hours—100 marks.

1. An iron ball 4 inches in diameter weighs 9 lbs., what does an iron ball 8 inches in diameter weigh?
2. A contractor was ordered to metal a public road 2 miles long with laterite—the width to be 6 yards and depth of metal $4\frac{1}{2}$ inches. The rate was Rs. 1-4-0 per cubic yard. When the work was measured, the metal was found to be only 4 inches thick. How much would Government have lost if the contractors had been paid the full amount?
3. A carpenter was told to make 2 open deal boxes to hold each 32 cubic feet. He made one 4 feet square and 2 feet high, and the other in the form of a cube. How many more square feet of planking (neglecting overlap) did the one contain than the other?
- N. B. $\sqrt[3]{32} = 3.175.$
4. A sack laid flat measures 6 feet long by 3 broad. How many cubic feet will it hold allowing $1\frac{1}{2}$ feet for tying up the mouth?
5. An earthen embankment has to be carried across a valley the banks of which are on a level with each other. The Section of the valley is an isosceles triangle with a base of 2,000 feet and altitude 60—The side slopes are to be 45° and width of embankment at top 25 feet. How many cubic feet of earth are required to construct it.
6. A Target 3 feet in diameter has a bull's eye and two rings so arranged that the areas of the bull's eye and that of each ring are all equal. What is the width of each.
7. What proportion does the statute brick $9'' \times 4\frac{1}{4}'' \times 3''$ bear to the Roman brick $12'' \times 6'' \times 3''$ in solid content.
8. A cubical box having each of its sides one foot was filled with iron balls each 1 inch in diameter. A similar box had in it a single iron ball of 1 foot diameter. What was the cubical content of iron in each box.
9. A House 40×20 is to be roofed in with tiles—Length of rafter 13 feet. Compare the quantities of roofing required in a hip roof and in a gabled roof.

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FIRST DEPARTMENT.

EUCLID.

Time 3 hours—100 Marks.

J. ANDERSON, ESQ., EXAMINER.

1. Triangles on equal bases and between the same parallels are equal. Take the case when the triangles have a common vertex.
2. The perpendicular is the shortest straight line that can be drawn from a given point to a given straight line.
3. Triangles on the same base and having equal vertical angles have their vertices in the circumference of a circle.
4. If the opposite angles of a quadrilateral be together equal to two right angles, a circle can be described about it.
5. Describe a circle passing through two given points and having its centre in a given line. What condition is necessary?
6. If two exterior angles of a triangle be bisected and from the point of intersection of the bisecting lines a line be drawn to the opposite angle of the triangle, the angle will be bisected. What does the point enable us to describe?
7. A segment of a circle is given: describe the circle of which it is the segment. How many cases does Euclid give? How may they be reduced to one?
8. Is Euclid's statement of the condition under which four quantities are proportional a definition or a test? Give the statement: illustrate it; and compare it with the one usually given in works on Algebra.

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FIRST DEPARTMENT.

ARITHMETIC.

Time 3 hours—150 Marks.

REV. J. BAMFORTH, EXAMINER.

I. Find the value of 275 cwts., 3 qrs., 25 lbs., at 30 Rs., 12 As., 6 Pie per cwt.

II. (1) What are recurring decimals?

(2) Find the vulgar fraction equivalent to the recurring decimal $\cdot 81246\cdot 246$.

(3) Shew that the recurring periods for $\frac{1}{7}$, $\frac{2}{7}$, $\frac{3}{7}$, $\dots$, $\frac{6}{7}$, will consist of the same digits.

III. Define discount : and find the present value of £.793 due six months hence, interest being at $3\frac{1}{2}$ per cent.

IV. A person invests a certain sum in the 3 per cents. when they are at $96\frac{3}{4}$; had he waited until they had fallen to $96\frac{1}{4}$, he would have obtained £16 more stock : how much money did he invest, $\frac{1}{8}$ per cent. being charged for Brokerage?

V. If 12 men perform a piece of work in 20 days, what number of men will be required to perform another piece of work four times as great in a fifth part of the time?

VI. Simplify

$$\frac{5\frac{1}{2} - 2\frac{1}{2}}{3\frac{1}{2} + \frac{9}{20}} \text{ of } \frac{4\frac{1}{2} + 5\frac{1}{2}}{4\frac{1}{20}} \text{ of } \frac{2\frac{1}{2} + 1\frac{3}{4}}{7\frac{1}{2} - 2\frac{1}{4}}$$

VII. (1) Extract the square root of $3\frac{1}{2}$ to five places of decimals.

(2) Extract the cube root of 352045367981.

VIII. A can earn £1 in 3 days, A and B together earn £9 in 12 days, and B and C together £35 10s. in 42 days : compare the rates of wages of A, B, and C.

IX. Find the difference between the Simple and Compound Interest on $100\frac{1}{2}$ guineas, for 3 years, at $4\frac{1}{2}$ per cent.

X. If a wall 320 yds. long, 9 ft. high, and $22\frac{1}{2}$ inches thick, be built by 10 men in 45 days of 12 hours each : in how many days of 14 hours each would 60 men build a wall 14 ft. high, $2\frac{1}{2}$ ft. thick, round a park $3\frac{1}{2}$ miles in circumference?

XI. A rectangular cistern, of which the length is $133\frac{3}{4}$ ft., and the breadth 6 ft., contains $294\frac{1}{4}$ cubic ft. of water ; what is the depth of the cistern, and what is the weight of water when one cubic inch weighs 252.5 grains?

XII. (1) Shew that any whole number, 765468, may be expressed by the sum of its digits, each multiplied by the power of 10 which its place in the number represents.

(2) Shew also, that a number is divisible by 9, when the sum of its digits is divisible by 9. and only then.

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FIRST DEPARTMENT.

ALGEBRA.

Time 3 hours—150 Marks.

REV. J. BAMFORTH, EXAMINER.

I. Reduce to its lowest terms—

$$\frac{3x^2 + 12x + 9}{x^3 + 5x^2 + 6}$$

II. Investigate the expression $\frac{a^m}{a^n} = a^{m-n}$.

What is the meaning of the result, when m is equal to n ?

III. Shew that $xy = a(x + y)$

if $x = \frac{2abc}{ac + bc - ab}$, and $y = \frac{2abc}{ab + bc - ac}$

IV. Solve the following equations :—

(1) $\frac{x}{a} + \frac{x+b}{a+b} + \frac{x+c}{a+c} = 3$

(2) $\left. \begin{aligned} \frac{5x}{3} - 16 + \frac{2y}{5} &= 18 - y \\ \frac{x}{4} - \frac{7y}{2} - 1 &= 3(1 - x) \end{aligned} \right\}$

(3) $1 + \frac{y+5}{12-x} : \frac{7x-6}{5} : \frac{3x-10}{14+y} : 1 : 8.$

(4) $\sqrt{x^2 - 2x + 93} - \frac{x^2}{2} = 45 - x$

V. A cistern is filled in 20 minutes by 3 pipes, one of which conveys 10 gallons more, and the other 5 gallons less, than the third per minute. The cistern holds 820 gallons. How much flows through each pipe in a minute?

VI. Two messengers, A and B, were despatched to the same place, 90 miles distant. A, by riding one mile an hour more than B, arrives at his destination an hour before him. How many miles an hour did each travel?

VII. Divide $8a^{\frac{3}{2}} + b^{-\frac{1}{2}} - c + 6a^{\frac{1}{2}}b^{-\frac{1}{2}}c^{\frac{1}{2}}$

by $2a^{\frac{1}{2}} + b^{-\frac{1}{2}} - c^{\frac{1}{2}}$

VIII. In how many ways can £1 be paid in half-crowns, shillings, and six pences, the number of coins at each payment being 18?

IX. (1) The sum of a decreasing arithmetic series is 149, the first term 10, and the common difference $\frac{1}{2}$; find the number of terms?

(2) Find the sum of 15 terms of the series

$$1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \dots$$

X. Required three numbers in Geometric progression whose sum is 91, and the sum of their squares 4159.

XL (1) Find a fourth proportional to 7, 63, 015.

(2) If $ax - by = cx + dy$, find the ratio $x : y$.

(3) If $a : b :: c : d$, prove (1) $a^2 : b^2 :: c^2 : d^2$.
(2) $a^3 + b^3 : c^3 + d^3 :: a^2 : c^2$.

(4) If $a : b :: \alpha : \beta$
 $b : c :: \beta : \gamma$
 $c : d :: \gamma : \delta$ } prove $a : d :: \alpha : \delta$

XII. (1) Show that the number of permutations of n things taken r together is
 $n(n-1)(n-2) \dots (n-r+1)$

(2) In how many ways may seven balls be arranged in two divisions, so that the first division may contain *three* of the balls, the second *four*?

XIII. Prove the Binomial Theorem, in the case in which n is a positive integer, and expand $(5 - \frac{1}{2})^6$

XIV. (1) Extract the square root of

$$31 + 12\sqrt{-6}.$$

(2) Extract the cube root of

$$27x^6 - 54x^5 + 63x^4 - 44x^3 + 21x^2 - 6x + 1.$$

9777 241. / 64

Arithmetic
and
Algebra.

Report of Examiners.

Howard / Parsons Examined in Arithmetic and Algebra &c. The examination in both subjects was with one or two exceptions very satisfactorily answered and I considered Mr. Rama Rao S. Subbaya and D. C. C. Subbaya in Arithmetic and Colundara in Algebra. Murgasam, Rama Rao and Chinnaya in Algebra to be deserving of special mention as having obtained more than $\frac{2}{3}$ the Maximum Number of Marks.

Euclid
Trigonometry

Mr. Anderson remarks that the examinations in Euclid and Trigonometry were very satisfactory in Euclid especially.

Hydraulics

Captain J. S. Hayes R.E. Examined in Hydraulics. Capt. C. C. Chappin and S. Subbaya have passed a pretty good examination obtaining 46 and 52 marks out of 100. The remainder have obtained about $\frac{1}{3}$ full marks.

Construction of Roads, Bridges &c.

Captain W. Gillock R.E. Examined in Construction of Roads, Bridges &c. Says. The answers to some of the Questions have come in an amount

amount of knowledge which I was
hardly prepared to expect. It is
W. Buckley and Rama Rao have dis-
tinguished themselves most, but all
the others have given me satisfaction.

Captain Rogers R.E. Hammer Measurement
in ^{Navigation} Drawing and etc. Drawing &
making reports. In measurement
3 students obtained more than $\frac{1}{2}$
full marks and Rama Rao and
J. Murgasam deserve special com-
mendations. On the whole the exami-
nation was decidedly satisfactory.
In drawing the plans
were for the most part neatly &
correctly drawn.

The remaining subjects of ^{Mechanics}
I ^{summed} in myself and am on the whole ^{Satisfying}
very well satisfied with the results.
The paper in Applied Mechanics
was generally the least satisfactory.
J. Subya ^{however} distinguished himself
greatly.

greatly in it.

W. Buckley
Principal

CIVIL ENGINEERING COLLEGE—MADRAS.

DETAILED RESULTS of the Examination held in December 1863.

Number.		FIRST DEPARTMENT.																						
		MATHEMATICS.				NAT. PHILOSOPHY.		MEASUREMENT AND ESTIMATING.		SURVEYING AND LEVELLING.		CIVIL ENGINEERING.		DRAWING.										
1	A. RAMA RAO.....	150	150	100	150	550	125	100	225	100	100	200	125	75	150	350	75	100	209	375	100	200	300	2,000
2	S. SUBBIAH.....	126	101	73	147	447	73	32	105	71	33	109	88	61	130	279	21	79	138	241	60	125	185	1,366
3	C. COLLENDAYAMOO MOODELLAR.	119	101	98	115	432	99	52	151	61	30	81	83	53	115	251	46	79	123	248	55	115	170	1,333
4	LIEUT. C. G. SANTON, R. A.....	93	113	73	141	420	83	28	111	46	28	74	76	51	140	270	25	68	127	220	57	140	197	1,292
5	P. MOOREGASIM MOODELLAR.....	101	87	60	56	304	40	46	86	43	28	71	75	46	130	251	20	75	150	245	65	90	155	1,112
6	G. RATNAM MOODELLAR.....	91	102	60	100	356	62	28	90	63	14	77	75	35	120	230	19	60	95	174	50	105	155	1,082
7	ST. J. H. BUCHAN.....	89	102	68	103	361	51	31	82	45	22	67	80	42	120	242	29	61	80	173	42	105	147	1,052
		66	71	53	72	265	27	18	45	26	26	52	68	45	100	213	20	70	111	234	43	90	133	942

CIVIL ENGINEERING COLLEGE,
Madras, 1st January, 1864.

G. V. S. SUDHIA, ASSISTANT PRINCIPAL.

W. H. EDGCOMB, CAPTAIN, R.E.,
Principal.

CIVIL ENGINEERING COLLEGE—MADRAS.

ABSTRACT STATEMENT of results of Examination held in December 1866.

Number.	FIRST DEPARTMENT.		Time at College.		Mathematics.	Natural Philosophy.	Mensuration and Estimating.	Surveying & Levelling.	Civil Engineering.	Drawing.	Grand Total.	REMARKS.
	<i>Per M.</i> Minimum for College Certificate as Assistant Engineer		Ye. Ma.		183	73	61	117	135	190	1,000	
1	A. RAMA RAO.	...	1	5	437	103	109	279	211	187	1,366	OBTAINED Certificate as Assistant Engineer.
2	S. SUBROTA.	...	1	5	432	151	81	251	248	170	1,333	
3	C. COJUNDAVALOO NOODELLIAR.	...	1	5	420	111	74	270	220	197	1,292	
4	LIEUT. G. C. SEXTON, R.A.	...	1	4	304	86	71	251	215	155	1,112	
5	P. MOORECASEN NOODELLIAR.	...	1	5	356	90	77	230	174	155	1,082	To remain in College.
6	G. RATNAM NOODELLIAR.	...	1	5	361	82	67	242	173	147	1,072	
7	ST. J. H. BUCHAN.	...	1	5	365	45	52	213	234	133	942	

CIVIL ENGINEERING COLLEGE,
Madras, 1st January 1864.

CHARTERED BY THE GOVERNMENT OF INDIA.

W. H. EDGECOME, CAPTAIN, R.E.,
Principal.

49/192446

149

[Handwritten signature]

I hereby certify that G. Rabnam M. D. holds
a student in the Department of the College has
passed with credit the Examination for Assistant
Engineer prescribed in Para 33 of Government Notifi-
cation dated 23rd June 1857

Civil Engineering College
Chester 10th January
1864

W. H. Burgess
Principal

Carson & Co.

277261/64

24

I hereby certify that 1st Maragasa
Montellier is a Student in 1st Department of
the College has passed with credit the examination
for Assistant Engineer prescribed in Para. 33 of
Government notification dated 23rd June 1857

Civil Engineering Society
 Chepstead 18th January
 1864

W. Eugene Cantrell
Principal

Defunct

I hereby certify that Lt. G. C. Saxton
a Student in the Department of the College has
passed with credit the examination for Assistant
Engineer prescribed in Para. 33 of Government
notification dated 28th June 1857.

W. H. Bagwell Captain R.E.

Principal

Civil Engineering Class
Opened 18th January
1864

28/1/64

299261/64

I hereby certify that C. Colindavales Masellon
a student in 1st Department of this College has
passed with credit the Examination for Assistant
Engineer prescribed in Para 33 of Government
Notification dated 23rd June 1857.

Principal.

Civil Engineering College
Chester N.B. Jan 17/64

Shereby certify that Arcot Rama Rao

Profile

Shereby certify that Sanyal Subroyachariar
a Student in 1st Department of this College has
passed with great credit the Examination for Assis-
tant Engineer prescribed in Para 33 of Government
Notification dated 23rd June 1857

Civil Engineering Class
Chopand 18th January 1864

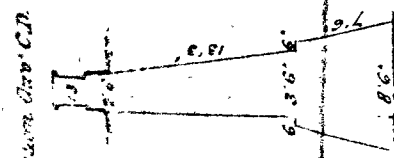
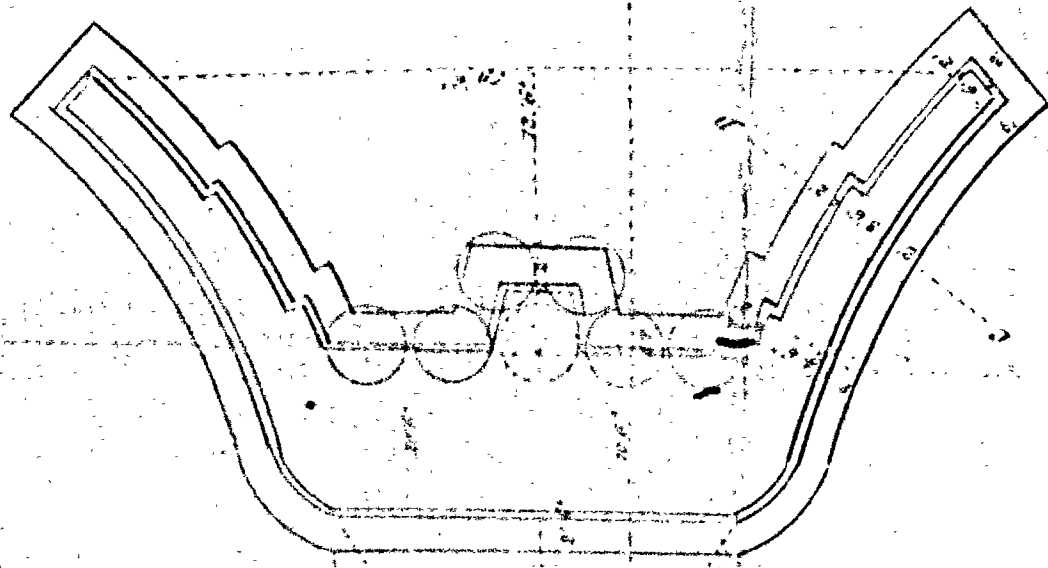
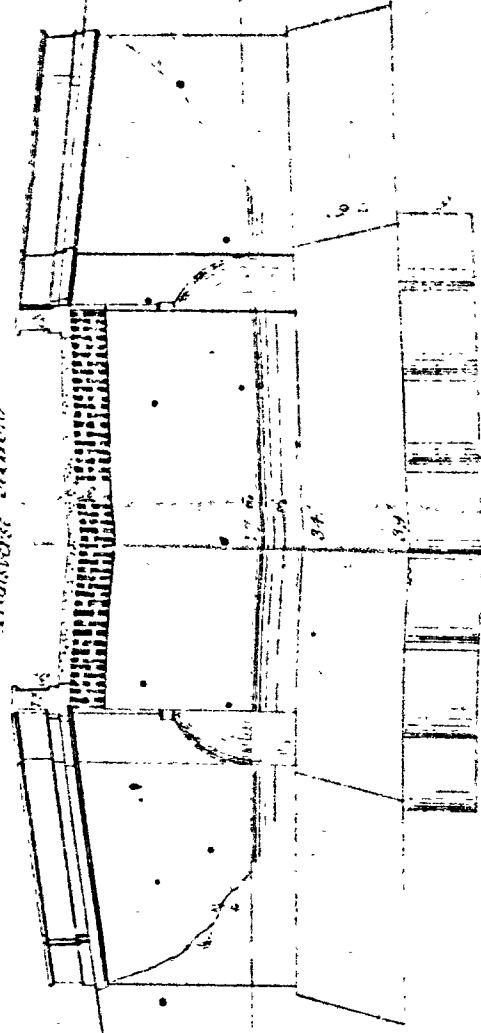
W. H. C. C. C.
Principal

389/26/1/64

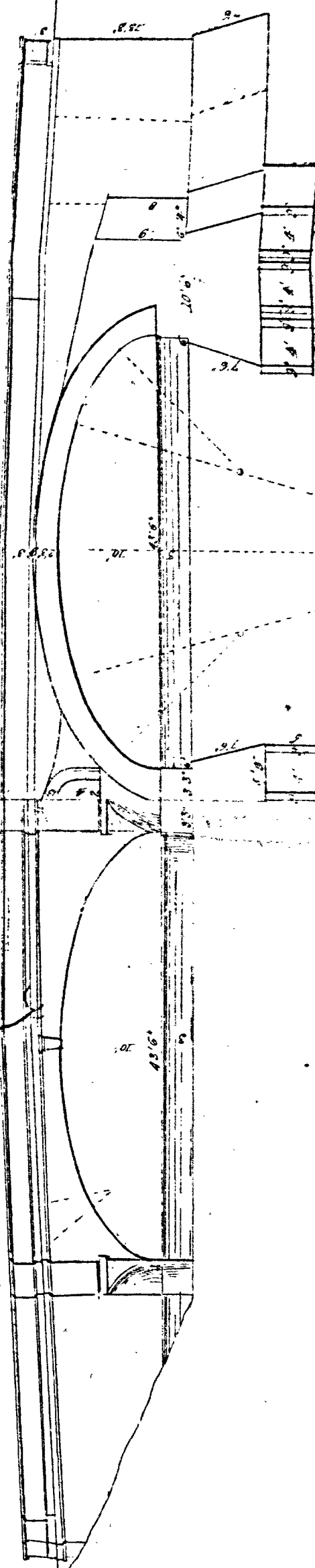
Civil Engineering College, Madras

Prepare an Estimate of quantities for the Bridge shown below.

Transverse Section

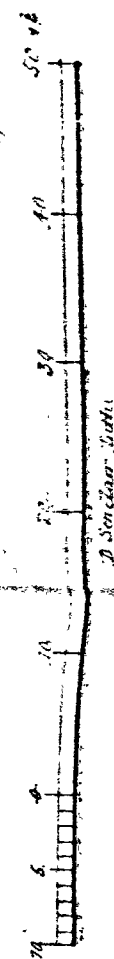


Section thro. A.R.



Elevation

Line of Roadway



Satisfactory, and the Tabular State-
ments show that Grand of the Cham
Examinations

2. Grand the Examinations to
submit 2 Tabular Statements showing
the results of the present examination
of Students of 1st Department of
the College for the grade of Lieut. Engi.
-near D.V.M. together with a set of
the Examination Papers employed.

2. In accordance with G.O.
No. 3505 dated 30 November 1863, Rev.
J. Bainton and Mr. Anderson were
appointed (with Captain J. G. Ryce
and myself) Examiners of the candidates,
but Captain Ryce owing to the
pressure of other business find only
some time to set & paper; I therefore
availed myself of the services of Cap.
Tulloch and Rogers R. E. to supply
his place.

3. I append a Summary of
the Examiners' Reports which I am
happy to state are generally very
Satisfactory

17 Nov 1863
15 Nov 1863
14 Nov 1863
13 Nov 1863

10-758

Civil Engineering Class
Sept 18. Jan 1864

granted to them

you will publish their names in
Fort Saint George Gazette.

Have the printer take
Sir,

Your most Obedt Servant

W. H. Lawrence Capt. &c

Principal

