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CINEC Campus

Faculty of Engineering & Technology

Bachelor of Science Honours in Engineering

CE4321- Construction Planning and Cost Estimation

MID - EXAMINATION PAPER

Date	:	**27th March 2025**
Examiner	:	**Mr. Kushan Hirimuthugoda**
Time Allowed	:	**Two Hours**

Instructions to Candidate

- This is an **open book** examination. The paper consists of two parts. **Part A and Part B**
- **All questions are compulsory**
- Use only the answers booklet, additional papers and graph paper for your answers.
- Write clearly and legibly with a blue or black pen.
- Write your name and student number on all sheets.

Part A

Select the most suitable answer for questions 1 to 20. Mark your answers on the paper itself.

1. Which of the following is a project?
    a. Repairing a car
    b. Running ready mix concrete plant
    c. Building an extension for an existing factory
        1. a only
        2. b only
        3. c only
        4. a and b only
        5. a and c only

2. Which of the following is NOT a project management process group?
    1. Initiating
    2. Planning
    3. Executing
    4. Programming
    5. Closing
3. You are the project manager of a multi-story building project and at the middle of the project the client wants to add a new car park which was not in the original design. But he needs to finish it with the completion of the other project. Which of the following tendering method will suite to the best
    1. Negotiated tendering
    2. Two stage tendering
    3. Open bid tendering
    4. Selective tendering
    5. Closed bid tendering

Use this for Question No. 3 and 4

Activity	Duration(Weeks)	Predecessor
Start	-	-
A	4	Start
B	3	A
C	4	B
D	5	Start
E	8	D
F	7	B
G	6	D
H	4	E,G
Finish	-	C,F,H

4. What is the critical path in the activity list?
    1. Start-A-B-C-Finish
    2. Start-A-D-F-Finish
    3. Start-D-E-H-Finish
    4. Start-D-G-H-Finish
    5. None of the above

5. What is the float for activity "F" in the activity list?
    1. 0
    2. 2
    3. 3
    4. 4
    5. 6

6. Which is NOT a key issue currently facing by the construction industry in Sri Lanka?
    1. Payment Delays
    2. Raising of material cost
    3. Difficult in importing goods
    4. Difficulty in land acquiring
    5. Suspended government projects

7. Which of the following is NOT correct about compaction equipment?
    1. Power Rammer is used to compact soil in narrow trenches
    2. Sheep's foot roller is an example for kneading compactor
    3. Tandem rollers are made with ballastable wheels which can increase the weight of the roller
    4. Vibratory rollers can be used in cohesive soils
    5. Tandem roller is an example for a static weight compactor

8. Which of the following are benefits of CIDA registration scheme?
    a. Client organizations can select the right contractor
    b. It motivates the contract for self-development
    c. It prevents contractors from undertaking projects beyond their capabilities
        1. a and b
        2. a and c
        3. b and c
        4. a only
        5. All

9. You are the project manager of a multi-story building. you are having enough technical officers to manage different activities like reinforcement works, formwork, concreting works, finishes etc... But your staff is not properly given the target tasks and responsibilities. what is the Management Theory that you are lagging of as per the Henry Feyol's Management Theories?
    1. Unity of command
    2. Unity of direction
    3. Scalar chain
    4. Order
    5. Stability of tenure personnel

10. Your company has asked you to provide a cost estimate that includes maintenance, installation, support, and upkeep costs for as long as the product will be used. What is that kind of estimate called?
    1. Benefit-cost ratio
    2. Depreciation
    3. Net present value
    4. Lifecycle costing
    5. Earned value management

11. In which of the following stages of a project you need Work Breakdown Structure (WBS)
    a. Estimating
    b. Scheduling
    c. Executing
    d. Monitoring and control
        1. a and b
        2. a and c
        3. c and d
        4. a , b and c
        5. All

12. You are managing to build a bridge. You work with your team and come up with a most likely estimate of 27 weeks to complete the job. In the Best case the project can be completed in 25 weeks because they have some precast beams. But there is a risk of bad weather where the project can be delayed by five weeks than the most likely estimate. Use PERT to calculate three –point estimate for this project.
    1. 25.83 weeks
    2. 26 weeks
    3. 27 weeks
    4. 27.5 weeks
    5. 28.3 weeks

13. You are managing a project and when your client tells you that an external problem happened, and now you have to meet an earlier deadline. Your supervisor heard that in a situation like this, you can use schedule compression by either crashing or fast tracking the schedule, but he's not sure which is which. What do you tell him?
    1. Crashing the project adds risk, while fast-tracking adds cost
    2. When you crash a project, it always shortens the total duration of the project
    3. Crashing the project adds cost, while fast-tracking adds risk
    4. When you fast-track a project, it always shortens the total duration of the project
    5. Both crashing and fast tracking will not work with scenario

14. Estimated cycle time of an excavator which is going to be used in a bulk excavation project is calculated as 2 minutes. The capacity of the bucket which is going to be used is $0.4m^3$ and the efficiency of the machine and the operator is estimated as 75%. Calculate the hourly production of the machine?
    1. $7.25m^3$
    2. $8.00m^3$
    3. $8.25m^3$
    4. $9.00m^3$
    5. $9.25m^3$

15. If the natural soil which is going to be excavated in Question 18 is having a compaction factor of 1.2, how many 1cube truck loads you need to transport the soil?
    1. 3
    2. 4
    3. 5
    4. 6
    5. 7

16. You are working on a project with an SPI of .72 and a CPI of 1.1. Which of the following BEST describes your project?
    1. Your project is ahead of schedule and under budget
    2. Your project is behind schedule and over budget
    3. Your project is behind schedule and under budget
    4. Your project is ahead of schedule and over budget
    5. Not enough data

17. Which of the following is NOT an advantage of Tendering Process?
    1. Allow for competition
    2. Neglect small contractors
    3. Prevents frauds
    4. Provide Transparency
    5. Protects Tax payers

18. What is a similar name for Slack
    1. Float
    2. Buffer
    3. Lag
    4. Reserve
    5. Schedule

19. Think that you are a project manager for renovation project and you are in the process of making the tenders. Your architect thinks that it's better to get to the opinion of the contractor regarding practically of the Design. Which tendering method is most suited for this situation?
    1. Open Bid Tendering
    2. Selective Tendering
    3. Closed Bid Tendering
    4. Negotiated Tendering
    5. Two Stage Tendering

20. In which item of a BOQ describes and specify the quality of materials and the standards of workmanship required for the proposed work
    1. Preliminaries
    2. Preambles
    3. Provisional Sums
    4. Contingencies
    5. Measured Works

(2x20=40 Marks)
(40minutes)

Part B

1. Write 3 methods of Tendering. Discuss advantages and disadvantages of each method with examples.

2. You are the project responsible PM for a project which has a budget of Rs.36,000 ,000.00 and a time duration of 12months. At the end of 3 months your actual completion is 45% and as your plan it has to be 40%. By that time, you have spent Rs.19,800,000.00 of your budget.

    i. Calculate; BAC, PV, AC, EV, SV, CV, SPI, CPI, TCPI, EAC, ETC, VAC
    ii. Based on Your answers explain the position of the project

3. You are a newly appointed Project Manager for a ongoing construction project. When you started work at site you identified several issues at site. There are enough staff and the workers. Bur they are not having a clear idea on what they are doing and their works are not efficient and they work for their personal goals. There was no one to guide them and no assigned works for them. There are lot of wastages of materials, tools and machineries. Explain how you can use Management Theories of Henry Feyol to overcome these issues. Use at least three theories and explain.

4. JKH is a construction company engaged in land reclamation projects. They decided to buy an JCB machine for their project for Rs. 15,000,000.00. They were able to negotiate with a leasing company to fund 75% of the amount of the machine with an annual interest rate of 8% which is fixed for all 5years. The interest is equally calculated to the capital on every year for the lease period of 5 years.

    In addition to all these JKH needs to pay Rs. 400,000.00 as a heavy vehicle tax for the government every year for all 5 years. They also arranged an insurance with a premium of Rs. 200,000.00 per year for all 5 years.

    JKH is expecting to sell the machine after 5 years with a salvage value of Rs. 5,000,000.00 and the company accountant is using Sum of Digits method to calculate the depreciation for the machine. The fuel consumption of the machine is 5l/hr and the lubricant consumption is 0.25l/hr. Assume that these consumptions and the tyres unchanged for the all 5years. The machine is expected to work an average of 6 hours per day for 300 days in a year for all 5 years.

    (Additional data: fuel price Rs.400.00/per liter, Lubricant price Rs.800.00/per liter, repair cost Rs. 500.00/per hr, operator wages Rs. 700.00/per hr. Assume all these prices will not change for all 5 years)

Help the newly appointed Project manager to find the following for the 3rd year of machine operations;

I. Machine Fixed cost
   a) Depreciation
   b) IIT
II. Machine variable cost
   a) Operator Wages
   b) Fuel
   c) Lubricant and Filter
   d) Repair and Maintenance
   e) Tyre
III. Total Owning and Operating Cost

(15x4 =60 Marks)
(80 minutes)

End of questions

CINEC CAMPUS
Beyond A Graduate

FACULTY OF ENGINEERING & TECHNOLOGY

BACHELOR OF SCIENCE HONOURS IN ENGINEERING

RESIT EXAMINATION

Module Code	:	**FE2321**
Module Title	:	**Engineering Mathematics IV**
Academic Year	:	**2025**
Date	:	**04th March 2025**
Examiner	:	**Dr. Shelton Perera**
Time Allowed	:	**3 Hours**

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination.
- You should answer all four questions. Each question carries equal marks.
- Each answer should start on a separate page.
- This paper contains 10 pages
- Additional information is provided on pages 6-10.

MATERIALS REQUIRED

- Two eight-page answer booklets
- You may use a Scientific calculator. This must not be programmable and may be inspected during the examination.

1.

i) Let $f(x,y,z) = x^2y + y^2z + z^2x$. Find the magnitude of the greatest rate of change of f at $(2,-1,1)$. (15 Marks)

ii) Consider the vector field $\boldsymbol{F} = (3x^2 + 2y)\boldsymbol{i} + (2x + 4z)\boldsymbol{j} + (4y + 5z)\boldsymbol{k}$
a) Show that $\boldsymbol{F}$ is irrotational. (15 Marks)
b) Find the divergence of $\boldsymbol{F}$ in general terms and at (1, 1, 1). (5 Marks)

iii) Let $f(x,y) = x^4 + 4x^2y^2 + 10y^2 - 20x^2 + y^4$.
a) Find $f_x(x,y)$, $f_y(x,y)$, $f_{xx}(x,y)$, $f_{yy}(x,y)$, and $f_{xy}(x,y)$. (10 Marks)
b) Find and classify the stationary points of f. (25 Marks)

iv) A rectangular storage container with an open top must have a volume of 32 cubic meters. Find the dimensions of the box that minimize the surface area. (30 Marks)

2.

i) Evaluate $\int_0^1 \int_0^{2x} \int_0^y xyz^3 dzdydx$. (25 Marks)

ii) Find the area of the region R enclosed between the curve $y = x^2 - 2x$ and the line $y = x - 2$ using a double integral. (20 Marks)

iii) Integrate the function $z = x + y$ over the triangle with vertices at (0,0), (2,2) and (4,0). (25 Marks)

iv) Find the Jacobian

$$J\left(\frac{x,\ y,\ z}{u,\ v,\ w}\right) = \begin{vmatrix} \frac{\partial x}{\partial u} & \frac{\partial x}{\partial v} & \frac{\partial x}{\partial w} \\ \frac{\partial y}{\partial u} & \frac{\partial y}{\partial v} & \frac{\partial y}{\partial w} \\ \frac{\partial z}{\partial u} & \frac{\partial z}{\partial v} & \frac{\partial z}{\partial w} \end{vmatrix},$$

if $x = u^2v + w$, $y = 2v + w^2$ and $z = 3u^2w$. (30 Marks)

3.

i) Let $\boldsymbol{F} = (3x^2y + z)\boldsymbol{i} + (x^3 + 2y)\boldsymbol{j} + (x + 2z)\boldsymbol{k}$.
Also let C_1 and C_2 be the curves from $O = (0,0,0)$ to $A = (1,1,1)$ given by

$$C_1 : \quad x = t, \quad y = t, \quad z = t \ (0 \le t \le 1)$$
$$C_2 : \quad x = t, \quad y = t^2, \quad z = t \ (0 \le t \le 1)$$

a) Find $\int_{C_1} \boldsymbol{F}.\boldsymbol{dr}$ and $\int_{C_2} \boldsymbol{F}.\boldsymbol{dr}$. (30 Marks

b) Find $\oint_C \boldsymbol{F}.\boldsymbol{dr}$, where C is the closed path along C_1 from O to A and back along C_2 from A to O. (5 Marks

c) Show that $\boldsymbol{F}$ is a conservative vector field by computing curl $\boldsymbol{F}$. (15 Marks)

d) Find a scalar field φ such that grad $\varphi = \boldsymbol{F}$.
Verify that $\int_{C_1} \boldsymbol{F}.\boldsymbol{dr} = \varphi(1,1,2) - \varphi(0,0,0)$.
(10 Marks)

ii) Let $f(t) = \begin{cases} 0, & -2 < t < 0 \\ 1, & 0 < t < 2 \end{cases}$ $\qquad f(t+4) = f(t)$.

a) Sketch a graph of $f(t)$ in the interval $-4 < t < 4$. (5 Marks)

b) Find the Fourier series representation of $f(t)$. (30 Marks

c) Use the series to obtain the identity:

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots$$

(5 Marks

4.

i) Let X be a continuous random variable with the probability density function given by

$$f(x) = \begin{cases} kx^2; & 0 \le x \le 3, \\ 0; & \text{otherwise.} \end{cases}$$

a) Find the value of k, (7 Marks)

b) Find $E(X)$. (9 Marks)

c) Find $P(X < 2 \mid X > 1)$. $\left(\text{Hint : } P(A|B) = \frac{P(A \cap B)}{P(B)}\right)$ (9 Marks)

ii) The weight of a particular brand of chocolate bars is assumed to be normally distributed with a mean of 150 grams and a standard deviation of 5 grams.

a) What is the probability that a randomly selected chocolate bar weighs more than 155 grams?

(7 Marks)

b) What is the probability that a chocolate bar weighs between 142 grams and 158 grams?

(10 Marks)

c) If the probability that the weight of a chocolate bar exceeds w is 0.0526, find the value of w.

(8 Marks)

iii) A manufacturer is testing the voltage output of a batch of 15 cells. Cells are supposed to have a nominal voltage of 10 volts. The following voltages (in volts) were measured for 15 randomly selected cells:

9.98, 10.05, 10.02, 10.07, 9.93, 9.97, 10.12, 10.03, 9.91, 10.06, 9.99, 10.04, 10.01, 9.98, 10.00.

If the measurement i is y_i, then $\sum_{i=1}^{15} {y_i}^2 = 1503.84$. Construct a 95% confidence interval for the population standard deviation σ. (20 Marks)

iv) A manufacturer is testing two different formulations of a chemical additive to determine if they affect the mean output of a production process. Formulation A is currently used, but Formulation B is a potential replacement due to its lower cost. A trial is conducted, and the following results are obtained:

Observation Number	Formulation 1	Formulation 2
1	102.3	100.5
2	105.8	103.1
3	98.6	97.2
4	101.4	100.9
5	99.5	101.7
6	103.2	102.8
7	100.1	99.3
8	104.6	103.5
	$\sum_{i=1}^{8} x_i^2 = 83274.78$	$\sum_{i=1}^{8} y_i^2 = 82201.34$

Assuming the populations have equal variances, test whether there is a significant difference in the mean output between the two formulations using a **5% significance level**.

(30 Marks)

Additional Information

Partial Derivatives

$$D = f_{xx}f_{yy} - (f_{xy})^2$$

Vector Calculus

The gradient of the scalar field $\phi = f(x, y, z)$ is $\quad \text{grad}\ \phi = \underline{\nabla}\phi = \dfrac{\partial \phi}{\partial x}\underline{i} + \dfrac{\partial \phi}{\partial y}\underline{j} + \dfrac{\partial \phi}{\partial z}\underline{k}$

Consider the vector field $\underline{F} = F_1\underline{i} + F_2\underline{j} + F_3\underline{k}$. $\quad \text{div}\ \underline{F} = \dfrac{\partial F_1}{\partial x} + \dfrac{\partial F_2}{\partial y} + \dfrac{\partial F_3}{\partial z}$.

The curl of the vector field given by $\underline{F} = F_1\underline{i} + F_2\underline{j} + F_3\underline{k}$ is defined as the vector field

$$\text{curl}\ \underline{F} = \underline{\nabla} \times \underline{F} = \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ \dfrac{\partial}{\partial x} & \dfrac{\partial}{\partial y} & \dfrac{\partial}{\partial z} \\ F_1 & F_2 & F_3 \end{vmatrix}$$

Fourier Series

$$a_n = \frac{2}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} f(t)\cos\left(\frac{2n\pi t}{T}\right)dt \qquad n = 0, 1, 2\ldots$$

$$b_n = \frac{2}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} f(t)\sin\left(\frac{2n\pi t}{T}\right)dt \qquad n = 1, 2\ldots$$

These integrals give the Fourier coefficients for a function of period T whose Fourier series is

$$f(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty}\left\{a_n\cos\left(\frac{2n\pi t}{T}\right) + b_n\sin\left(\frac{2n\pi t}{T}\right)\right\}$$

Continuous Random Variable

Let X be a continuous random variable with associated pdf $f(x)$. Then its expectation and variance denoted by $\mathsf{E}(X)$ (or μ) and $\mathsf{V}(X)$ (or σ^2) respectively are given by:

$$\mu = \mathsf{E}(X) = \int_{-\infty}^{\infty} x\ f(x)dx$$

and

$$\sigma^2 = \mathsf{V}(X) = \int_{-\infty}^{\infty}(x-\mu)^2 f(x)dx = \int_{-\infty}^{\infty} x^2 f(x)dx - \mu^2$$

Point Estimation

We estimate μ using the sample mean: $\bar{y} = \dfrac{\sum y_i}{n}$

We estimate σ^2 using the sample variance:

$$s^2 = \frac{1}{n-1}\sum(y_i - \bar{y})^2 = \frac{1}{n-1}\left\{\sum y_i^2 - \frac{1}{n}\left[\sum y_i\right]^2\right\}$$

Interval Estimation

It follows that if we do not know the population variance, we must use the estimate $\hat{\sigma}$ in place of σ. Our 95% and 99% confidence intervals (for large samples) become

$$\bar{x} - 1.96\frac{\hat{\sigma}}{\sqrt{n}} \leq \mu \leq \bar{x} + 1.96\frac{\hat{\sigma}}{\sqrt{n}} \quad \text{and} \quad \bar{x} - 2.58\frac{\hat{\sigma}}{\sqrt{n}} \leq \mu \leq \bar{x} + 2.58\frac{\sigma}{\sqrt{n}}$$

where

$$\hat{\sigma}^2 = \frac{\sum(x - \bar{x})^2}{n-1}$$

If $x_1, x_2, x_3, \cdots, x_n$ is a random sample with variance S^2 taken from a normal population with variance σ^2 then a $100(1-\alpha)\%$ confidence interval for σ^2 is

$$\frac{(n-1)S^2}{\chi^2_{\alpha/2,n-1}} \leq \sigma^2 \leq \frac{(n-1)S^2}{\chi^2_{1-\alpha/2,n-1}}$$

where $\chi^2_{\alpha/2,n-1}$ and $\chi^2_{1-\alpha/2,n-1}$ are the appropriate right-hand and left-hand values respectively of a chi-squared distribution with $n-1$ degrees of freedom.

Test Concerning Two Samples (Unknown But Equal Variances)

$$T = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{S_c\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

will follow Student's t-distribution with $n_1 + n_2 - 2$ degrees of freedom.

$$S_c^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$

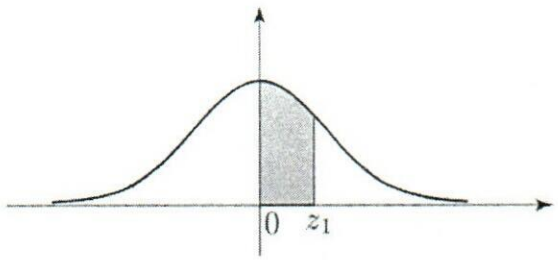
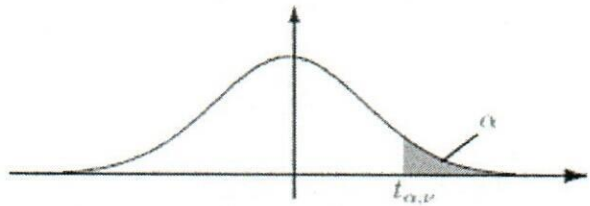


Figure 3

Table 1: The Standard Normal Probability Integral

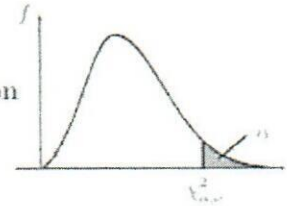
$Z=\frac{x-\mu}{\sigma}$	0	1	2	3	4	5	6	7	8	9
0	0000	0040	0080	0120	0160	0199	0239	0279	0319	0359
.1	0398	0438	0478	0517	0577	0596	0636	0675	0714	0753
.2	0793	0832	0871	0909	0948	0987	1026	1064	1103	1141
.3	1179	1217	1255	1293	1331	1368	1406	1443	1480	1517
.4	1555	1591	1628	1664	1700	1736	1772	1808	1844	1879
.5	1915	1950	1985	2019	2054	2088	2123	2157	2190	2224
.6	2257	2291	2324	2357	2389	2422	2454	2486	2517	2549
.7	2580	2611	2642	2673	2703	2734	2764	2794	2822	2852
.8	2881	2910	2939	2967	2995	3023	3051	3078	3106	3133
.9	3159	3186	3212	3238	3264	3289	3315	3340	3365	3389
1.0	3413	3438	3461	3485	3508	3531	3554	3577	3599	3621
1.1	3643	3665	3686	3708	3729	3749	3770	3790	3810	3830
1.2	3849	3869	3888	3907	3925	3944	3962	3980	3997	4015
1.3	4032	4049	4066	4082	4099	4115	4131	4147	4162	4177
1.4	4192	4207	4222	4236	4251	4265	4279	4292	4306	4319
1.5	4332	4345	4357	4370	4382	4394	4406	4418	4429	4441
1.6	4452	4463	4474	4484	4495	4505	4515	4525	4535	4545
1.7	4554	4564	4573	4582	4591	4599	4608	4616	4625	4633
1.8	4641	4649	4656	4664	4671	4678	4686	4693	4699	4706
1.9	4713	4719	4726	4732	4738	4744	4750	4756	4761	4767
2.0	4772	4778	4783	4788	4793	4798	4803	4808	4812	4817
2.1	4821	4826	4830	4834	4838	4842	4846	4850	4854	4857
2.2	4861	4865	4868	4871	4875	4878	4881	4884	4887	4890
2.3	4893	4896	4898	4901	4904	4906	4909	4911	4913	4916
2.4	4918	4920	4922	4925	4927	4929	4931	4932	4934	4936
2.5	4938	4940	4941	4943	4946	4947	4948	4949	4951	4952
2.6	4953	4955	4956	4957	4959	4960	4961	4962	4963	4964
2.7	4965	4966	4967	4968	4969	4970	4971	4972	4973	4974
2.8	4974	4975	4976	4977	4977	4978	4979	4979	4980	4981
2.9	4981	4982	4982	4983	4984	4984	4985	4985	4986	4986
	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
	4987	4990	4993	4995	4997	4998	4998	4999	4999	4999

Table 2: Percentage Points of the Students t-distribution



α	.40	.25	.10	.05	.025	.01	.005	.0025	.001	.0005
ν										
1	.325	1.000	3.078	6.314	12.706	31.825	63.657	127.32	318.31	636.62
2	.289	.816	1.886	2.902	4.303	6.965	9.925	14.089	23.326	31.598
3	.277	.765	1.638	2.353	3.182	4.541	5.841	7.453	10.213	12.924
4	.271	.741	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	.267	.727	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	.265	.718	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	.263	.711	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	.262	.706	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	.261	.703	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	.260	.700	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.487
11	.260	.697	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	.259	.695	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	.259	.694	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	.258	.692	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	.258	.691	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	.258	.690	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	.257	.689	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965
18	.257	.688	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	.257	.688	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	.257	.687	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	.257	.686	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	.256	.686	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	.256	.685	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.767
24	.256	.685	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	.256	.684	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26	.256	.684	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27	.256	.684	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28	.256	.683	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674
29	.256	.683	1.311	1.699	2.045	2.462	2.756	3.038	3.396	3.659
30	.256	.683	1.310	1.697	2.042	2.457	2.750	3.030	3.385	3.646
40	.255	.681	1.303	1.684	2.021	2.423	2.704	2.971	3.307	3.551
60	.254	.679	1.296	1.671	2.000	2.390	2.660	2.915	3.232	3.460
120	.254	.677	1.289	1.658	1.980	2.358	2.617	2.860	3.160	3.373
∞	.253	.674	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291

Table 3 : Percentage Points $\chi^2_{\alpha,\nu}$ of the χ^2 distribution



α	0.995	0.990	0.975	0.950	0.900	0.500	0.100	0.050	0.025	0.010	0.005
ν											
1	0.00	0.00	0.00	0.00	0.02	0.45	2.71	3.84	5.02	6.63	7.88
2	0.01	0.02	0.05	0.01	0.21	1.39	4.61	5.99	7.38	9.21	10.60
3	0.07	0.11	0.22	0.35	0.58	2.37	6.25	7.81	9.35	11.34	12.28
4	0.21	0.30	0.48	0.71	1.06	3.36	7.78	9.49	11.14	13.28	14.86
5	0.41	0.55	0.83	1.15	1.61	4.35	9.24	11.07	12.83	15.09	16.75
6	0.68	0.87	1.24	1.64	2.20	5.35	10.65	12.59	14.45	16.81	18.55
7	0.99	1.24	1.69	2.17	2.83	6.35	12.02	14.07	16.01	18.48	20.28
8	1.34	1.65	2.18	2.73	3.49	7.34	13.36	15.51	17.53	20.09	21.96
9	1.73	2.09	2.70	3.33	4.17	8.34	14.68	16.92	19.02	21.67	23.59
10	2.16	2.56	3.25	3.94	4.87	9.34	15.99	18.31	20.48	23.21	25.19
11	2.60	3.05	3.82	4.57	5.58	10.34	17.28	19.68	21.92	24.72	26.76
12	3.07	3.57	4.40	5.23	6.30	11.34	18.55	21.03	23.34	26.22	28.30
13	3.57	4.11	5.01	5.89	7.04	12.34	19.81	22.36	24.74	27.69	29.82
14	4.07	4.66	5.63	6.57	7.79	13.34	21.06	23.68	26.12	29.14	31.32
15	4.60	5.23	6.27	7.26	8.55	14.34	22.31	25.00	27.49	30.58	32.80
16	5.14	5.81	6.91	7.96	9.31	15.34	23.54	26.30	28.85	31.00	34.27
17	5.70	6.41	7.56	8.67	10.09	16.34	24.77	27.59	30.19	33.41	35.72
18	6.26	7.01	8.23	9.39	10.87	17.34	25.99	28.87	31.53	34.81	37.16
19	6.84	7.63	8.91	10.12	11.65	18.34	27.20	30.14	32.85	36.19	38.58
20	7.43	8.26	9.59	10.85	12.44	19.34	28.41	31.41	34.17	37.57	40.00
21	8.03	8.90	10.28	11.59	13.24	20.34	29.62	32.67	35.48	38.93	41.40
22	8.64	9.54	10.98	12.34	14.04	21.34	30.81	33.92	36.78	40.29	42.80
23	9.26	10.20	11.69	13.09	14.85	22.34	32.01	35.17	38.08	41.64	44.18
24	9.89	10.86	12.40	13.85	15.66	23.34	33.20	36.42	39.36	42.98	45.56
25	10.52	11.52	13.12	14.61	16.47	24.34	34.28	37.65	40.65	44.31	46.93
26	11.16	12.20	13.84	15.38	17.29	25.34	35.56	38.89	41.92	45.64	48.29
27	11.81	12.88	14.57	16.15	18.11	26.34	36.74	40.11	43.19	46.96	49.65
28	12.46	13.57	15.31	16.93	18.94	27.34	37.92	41.34	44.46	48.28	50.99
29	13.12	14.26	16.05	17.71	19.77	28.34	39.09	42.56	45.72	49.59	52.34
30	13.79	14.95	16.79	18.49	20.60	29.34	40.26	43.77	46.98	50.89	53.67
40	20.71	22.16	24.43	26.51	29.05	39.34	51.81	55.76	59.34	63.69	66.77
50	27.99	29.71	32.36	34.76	37.69	49.33	63.17	67.50	71.42	76.15	79.49
60	35.53	37.48	40.48	43.19	46.46	59.33	74.40	79.08	83.30	88.38	91.95
70	43.28	45.44	48.76	51.74	55.33	69.33	85.53	90.53	95.02	100.42	104.22
80	51.17	53.54	57.15	60.39	64.28	79.33	96.58	101.88	106.63	112.33	116.32
90	59.20	61.75	65.65	69.13	73.29	89.33	107.57	113.14	118.14	124.12	128.30
100	67.33	70.06	74.22	77.93	82.36	99.33	118.50	124.34	129.56	135.81	140.17

- End of Examination Paper –

CINEC CAMPUS
Beyond A Graduate

Faculty of Engineering & Technology

Bachelor of Science Honours in Engineering

EE2327 – Electrical Power & Machines

Resit Sit EXAMINATION PAPER (Semester 4)

Date : 28/02/2025

Examiner : Mr. Amila Nuwan Sanjeewa

Time Allowed: 3 Hours

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination.
- The question paper consists of **five** questions in **four** pages.
- **Answer all questions.**
- You may use a scientific calculator. This must not be programmable and may be inspected during the examination.

01. (a)

1. Define power factor of a load. **(1 marks)**
2. What is the meaning of lagging power factor and leading power factor? **(2marks)**

(b)

1. What techniques can be used to improve power factor in the power system? **(2marks)**
2. Discuss Benefits of power factor correction. **(3marks)**

(c)

1. Proof an equation for capacitor which is used in power factor correction. (Relevant sketches also can be use) **(3marks)**
2. State Energy Audit process. **(2marks)**
3. Discuss the role of Energy manager. **(3marks)**

(d)

A synchronous motor improves the power factor of a load of 500kW from 0.75 lagging to 0.90 lagging. Simultaneously the motor carries a load of 100kW.

1. Find the leading kVAR taken by the motor, kVA rating of the motor, and power factor at which the motor operates.
2. Instead of a synchronous motor, find the capacitance that can improve the power factor from 0.75 lagging to 0.90 lagging. **(4marks)**

02. (a)

1. What is the importance of protection of electrical wiring? **(1marks)**
2. List suitable electrical protection device that can be used for. **(2marks)**
   - i. Over current
   - ii. Short circuit
   - iii. Earth leakage
   - iv. Surge
3. State the difference between ring and radial circuit. **(2marks)**

(b)

1. Draw three phase consumer connection diagram. **(3marks)**

(c) 1. List important factors to be considered when energy generation planning? **(2marks)**

2. What are the cons of variable load in power system? **(2marks)**

(d) Study the power system shown in Figure 2.1. Rated power output of each generator is 150MW. Power ratings of L1, L2, L3 and L4 loads are 100MW, 120MW, 140MW and 110MW respectively. Daily power consumption profile of the three loads are given in the Table 2.1. Draw the daily load curve and the daily load duration curve for the given power system. Find following values for the power plant. **(8marks)**

i. Installed/plant capacity
ii. Connected load
iii. Peak demand
iv. Average load
v. Reserve capacity
vi. Demand factor
vii. Load factor
viii. Utilization factor

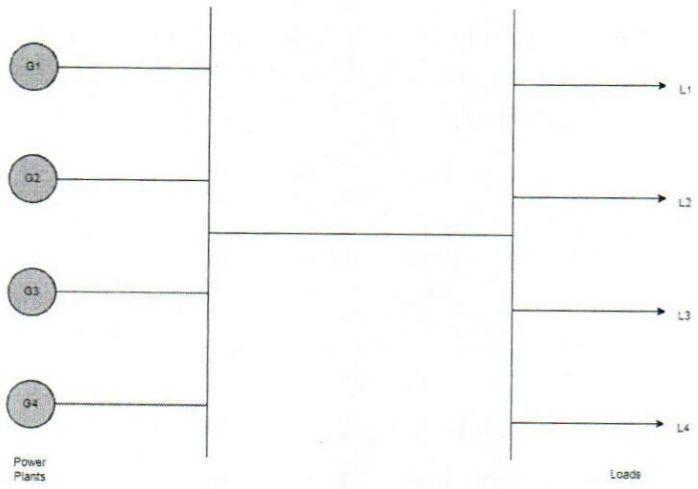


Figure 2.1: Power System

Table 2.1: Daily power consumption profile

	24.00-03.00	03.00-06.00	06.00-09.00	09.00-12.00	12.00-15.00	15.00-18.00	18.00-21.00	21.00-24.00
L1	35	40	50	65	55	70	80	45
L2	45	55	65	75	60	75	90	60
L3	60	70	75	100	80	95	135	115
L4	50	60	100	60	40	20	10	25

03. (a) What are the types of construction for transformer core? **(2 marks)**

(b) List the losses associated with the transformer. **(3marks)**

(c) 1. Draw the phasor diagram of a transformer. **(3marks)**

Hint: $\frac{V_p}{a} \cong V_s + R_{eq}I_sCos\theta + X_{eq}I_sSin\theta$

2. Draw the equivalent circuit of the transformer and hence obtain the referred to secondary circuit with usual notations. **(5marks)**

(d) Solve for the current, load voltage and load power in the circuit shown in figure 3.1 using per unit analysis with an S_B of 250 MVA, and voltage bases of 8 kV, 80 kV and 16 kV, respectively. **(7marks)**

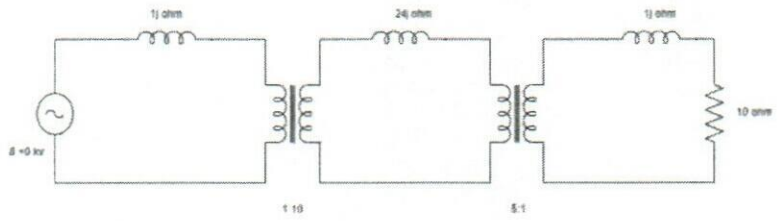


Figure 3.1: Power system circuit

04. (a) 1. Briefly explain the laws associated with the DC motor operation. **(2marks)**

2. List out the main components of DC machine. **(3marks)**

(b) 1. Explain the Open Circuit Characteristics (OCC) for DC machine with essential sketches. **(4marks)**

2. What is the meaning of armature reaction? **(1marks)**

(c) 1. Define the DC generator and list the types of it. **(2marks)**

2. Sketch the power flow diagram of DC Generator. **(2marks)**

(d) 1. What are the characteristics of shunt DC generators? **(3marks)**

2. Draw the performance graph of shunt DC generators. **(3marks)**

05. (a)

1. State the difference between synchronous motor and induction motor. **(3marks)**

2. What is the meaning of excitation in synchronous motor? **(3marks)**

(b) Describe briefly the losses involve with synchronous motor. **(3marks)**

(c) Explain about rotating magnetic field of induction motor. **(5 marks)**

(d) Explain briefly on "wound rotor induction motor" and "squirrel cage induction motor". **(6marks)**

End of paper

CINEC CAMPUS
Beyond A Graduate

Faculty of Engineering & Technology

Bachelor of Science Honours in Engineering

ME2322 – Fluid Dynamics

FINAL EXAMINATION PAPER (Semester 4)

Date : 26/02/2025

Examiner : Mr. R.Y. Sampath

Time Allowed : 3 h

Additional Material Provided

- Relevant data tables and equations are provided at the end of the paper.

Instructions to Candidates

- This is a closed-book examination.
- This paper consists of five (5) questions.
- Answer all questions.
- All questions carry equal marks as indicated against each question or part thereof.
- Do not use red ink in answering the questions.
- All drawings or sketches, if any, should be produced clearly.
- Assume reasonable values for any data not given with the question paper. Clearly state any assumptions.
- An electronic non-programmable calculator approved by the faculty may be used.
- All examinations are conducted in accordance with the Rules & Regulations currently in force at the University.

1			**[Total 20 marks]**	
	a)		Briefly explain the difference between ideal fluids and real fluids.	(02 marks)
	b)		Calculate the specific weight, specific mass, specific volume and specific gravity of a liquid having a volume of 6 m^3 and weight of 36 kN.	(08 marks)
	c)		A plate 0.05 mm distant from a fixed plate moves at 1.2 m/s and requires a force of 2.2 N/m^2 to maintain this speed. Find the viscosity of the fluid between the plates.	(10 marks)
2			**[Total 20 marks]**	
	a)		Two large fixed parallel planes are 13 mm apart. The space between the surfaces is filled with oil of viscosity 0.972 Ns/m^2. A flat thin plate 0.25 m^2 area moves through the oil at a velocity of 0.35 m/s. Calculate the drag force,	
		i)	When the plate is equidistant from both the planes	(02 marks)
		ii)	When the thin plate is at a distance of 5 mm from one of the plane surfaces.	(04 marks)
	b)		Calculate the pressure at a point 5 m below the free water surface in a liquid that has a variable density given by relation: $\rho = (350 + Ay)$ kg/m^3, where, $A = 8$ kg/m^4 and y is the distance in meters measured from the free surface.	(06 marks)
	c)		Briefly describe the following.	
		i)	Rotational and Irrotational Flows	(02 marks)
		ii)	Laminar and Turbulent Flows	(02 marks)
		iii)	Compressible and Incompressible Flows	(02 marks)
		iv)	Streamline and Stream Tube	(02 marks)
3			**[Total 20 marks]**	
	a)		Draw a neat sketch of the Reynolds apparatus and explain how the laminar flow can be demonstrated with the help of the apparatus.	(04 marks)
	b)		Find the velocity and acceleration at a point (1, 2, 3) after 1 sec. for a three-dimensional flow given by $u = yz + t$, $v = xz - t$, $w = xy$ m/s.	(06 marks)
	c)		A pipe (1) 450 mm in diameter branches into two pipes (2 and 3) of diameters 300 mm and 200 mm respectively as shown in Fig. Q3. If the average velocity in 450 mm diameter pipe is 3 m/s find:	
		i)	Discharge through 450 mm diameter pipe.	(04 marks)
		ii)	Velocity in 200 mm diameter pipe if the average velocity in 300 mm pipe is 2.5 m/s.	(06 marks)

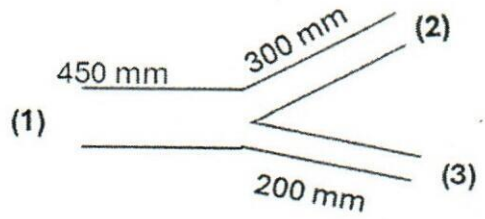
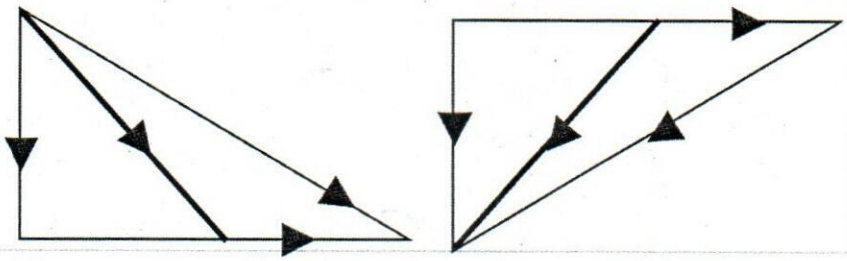


Fig. Q3

4				**[Total 20 marks]**
	a)		How to classify the turbulent motion in a fluid flow?	(03 marks)
	b)		A rectangular notch 0·5 m long is used for measuring a discharge of 0·04 m^3/s. An error of 2 mm was made in measuring the head over the notch. Calculate the percentage error in the discharge. Take Cd = 0·6.	(07 marks)
	c)		A smooth pipe of 75 mm diameter and 1000 m long is carrying water at the rate of 0.008m^3/s. If the kinematic viscosity of water is 0·014 x 10^{-4} m^2/s and the value of co-efficient of friction 'f' is given by the relation $f = \frac{0.0791}{Re^{1/4}}$, where R_e is Reynolds number, Calculate:	
		i)	Loss of head,	(02 marks)
		ii)	Wall shearing stress	(02 marks)
		iii)	Centre-line velocity	(02 marks)
		iv)	Velocity and shear stress at 20 mm from the pipe wall	(02 marks)
		v)	Thickness of laminar sublayer	(02 marks)
5				**[Total 20 marks]**
	a)		Briefly explain the difference between "Pelton Turbine" and "Reaction Turbine".	(06 marks)
	b)		A curved vane fixed on a wheel on the surface receives water at angle of 20^0 to the tangent of the wheel. The inner and outer diameter of the wheel are 0.9m and 1.6m respectively. The speed of rotation of the wheel is 7 revolutions per second. The velocity of water at entry is 75 m/s. The water leaves the blade with an absolute velocity of 21 m/s at an angle of 120^0 with the wheel tangent at outlet. The flow rate is 400kg/s. Determine,	(14 marks)
		i)	the blade angles for shockless entry and exit	
		ii)	the torque and power	
		iii)	the radial force	
			Hint:	



~ End of the question paper ~

DATA SHEET

$Q = \frac{2}{3} C_d . L \sqrt{2g}\, H^{3/2}$	$\delta' = \frac{11.6\,\nu}{u_f}$
$\tau_2 = u . \left(\frac{du}{dy}\right)_2$	$(p_1 - p_2) = \Delta p = \frac{32\mu\bar{u}\,L}{D^2}$
$Re = \frac{\rho VD}{\mu}$	$-\frac{\partial p}{\partial x} = -\frac{p_2 - p_1}{x_2 - x_1}$
$P = F_D \times \bar{u}$	$h_f = \frac{p_1 - p_2}{w} = \frac{4fLV^2}{D \times 2g}$
$\tau_0 = \mu \cdot \left(\frac{\partial u}{dy}\right)_{y=0}$	$u = -\frac{1}{4\mu} \cdot \frac{\partial p}{\partial x} (R^2 - r^2)$
$\tau_0 = \frac{fV^2 \times w}{2g} = \frac{fV^2 \times \rho g}{2g} = \frac{f\rho V^2}{2}$	$\frac{u}{u_f} = 5.75 \log_{10}\left(\frac{y}{k}\right) + 8.5$
$\frac{u}{u_f} = 5.75 \log_{10}\left(\frac{u_f y}{\nu}\right) + 5.5$	$\tau = -\frac{\partial p}{\partial x} \times \frac{r}{2}$
$F_Y = -\rho Q V_2 \sin 60 - P_2 A_2 \sin 60$	
$F_X = P_1 A_1 + \rho Q V_1 - \rho Q V_2 \cos 60 + P_2 A_2 \cos 60$	

CINEC CAMPUS

FACULTY OF ENGINEERING & TECHNOLOGY

BACHELOR OF SCIENCE HONOURS IN ENGINEERING

ME3315 FINITE ELEMENT ANALYSIS

FINAL EXAMINATION PAPER (semester 05)

CINEC CAMPUS
Beyond A Graduate

Date	:	**31st January 2025**
Examiner	:	**Hasitha Wipulaguna**
Time Allowed	:	**3 Hours**

INSTRUCTIONS TO CANDIDATES

- This question paper consists of **6 questions.**
- Answer **5** questions out of **6**.
- You should write legibly in **black or blue ink pens**.
- Do not remove the question paper or part of it, out of the examination hall.
- Graph papers, blank answer books and separate blank sheets will be provided.
- Non programmable calculators are allowed.
- This is a closed book exam.
- Any data which is not given in the question paper should be reasonably assumed and clearly state such assumptions.

QUESTION 01 **[20 marks]**

a) Describe with flow charts, the major steps of in the use of Finite element Method software.
b) Describe the difference between FDM, FEM and FVM.
c) Describe the major steps of a "Static Structural" component in ANSYS Workbench.

QUESTION 02 **[20 marks]**

The members of the truss shown in Figure Q2 have a cross-sectional area of 0.001483 mm^2 and are made of aluminum alloy (E = 209 GPa).

Determine

a) the deflection of joint A,
b) the stress in each member, and
c) the reaction forces.

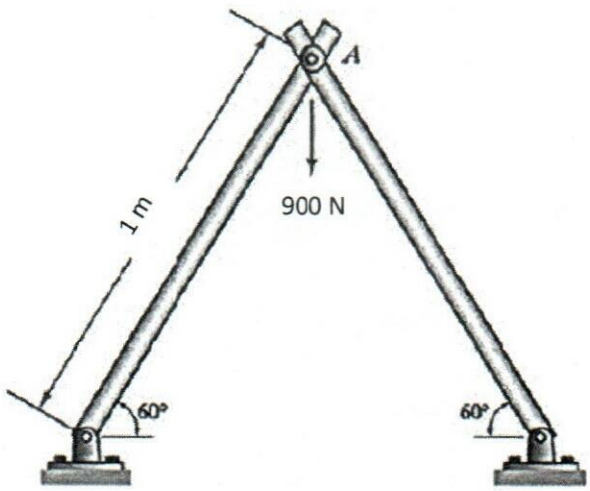


Figure Q2

QUESTION 03 **[20 marks]**

The plane truss shown in Figure Q3 consists of three trusses 1-2, 2-3 and 3-1.

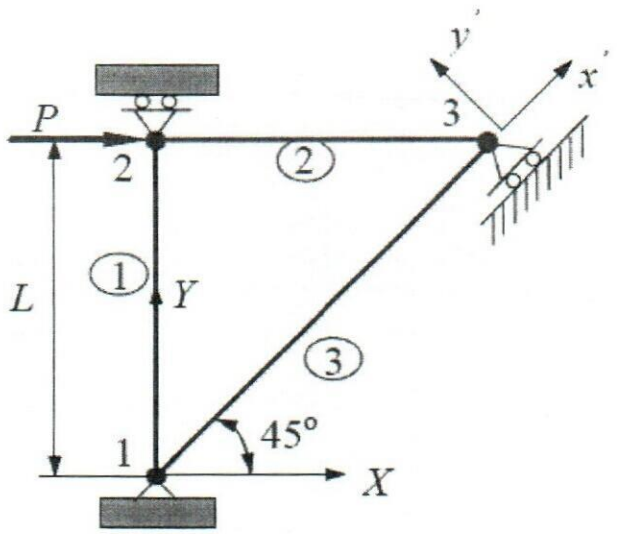


Figure Q3

For the plane truss shown above,

$P = 1000$ kN, $L = 1m$, $E = 210\,GPa$,

$A = 6.0 \times 10^{-4} m^2$ for elements 1 and 2,

$A = 6\sqrt{2} \times 10^{-4} m^2$ for element 3.

Using direct stiffness approach, find the displacements and the reaction forces of the system.

Hint: Use the following approach,

$$\frac{EA}{L}\begin{bmatrix} 1 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 1 \end{bmatrix}\begin{Bmatrix} u_1 \\ u_2 \\ u_3 \end{Bmatrix} = \begin{Bmatrix} F_1 \\ F_2 \\ F_3 \end{Bmatrix}$$

QUESTION 04 **[20 marks]**

The beam 1-3 shown in Figure Q4 is rigidly clamped at the two ends, and the moment M and downward force P are applied at midpoint 2.

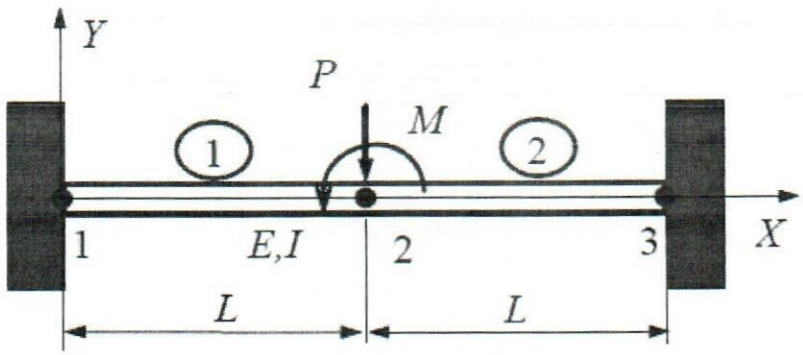


Figure Q4

Determine the deflection and rotation at the center node and the reaction forces and moments at the two ends.

Hint: Use the beam bending matrix,

$$\mathbf{k}_1 = \frac{EI}{L^3}\begin{bmatrix} v_1 & \theta_1 & v_2 & \theta_2 \\ 12 & 6L & -12 & 6L \\ 6L & 4L^2 & -6L & 2L^2 \\ -12 & -6L & 12 & -6L \\ 6L & 2L^2 & -6L & 4L^2 \end{bmatrix}$$

QUESTION 05 **[20 marks]**

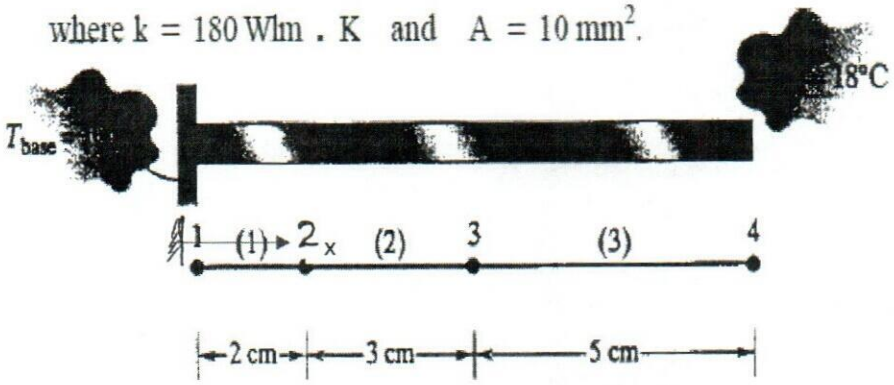
Figure Q5 illustrates a fin with linear one-dimensional elements to approximate temperature distribution over its length. The nodal temperatures at corresponding nodes and other necessary parameters and information are also given with the figure.

(a) What is the temperature of the fin at x = 7 cm?

(b) Evaluate the heat loss from the fin using the relationship

$$Q = -kA\frac{dT}{dX}\Big|_{x=0}$$

where k = 180 Wlm . K and A = 10 mm^2.



$$\begin{Bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \end{Bmatrix} = \begin{Bmatrix} 100 \\ 80 \\ 64 \\ 41 \end{Bmatrix} °C$$

Figure Q5

QUESTION 06 **[20 marks]**

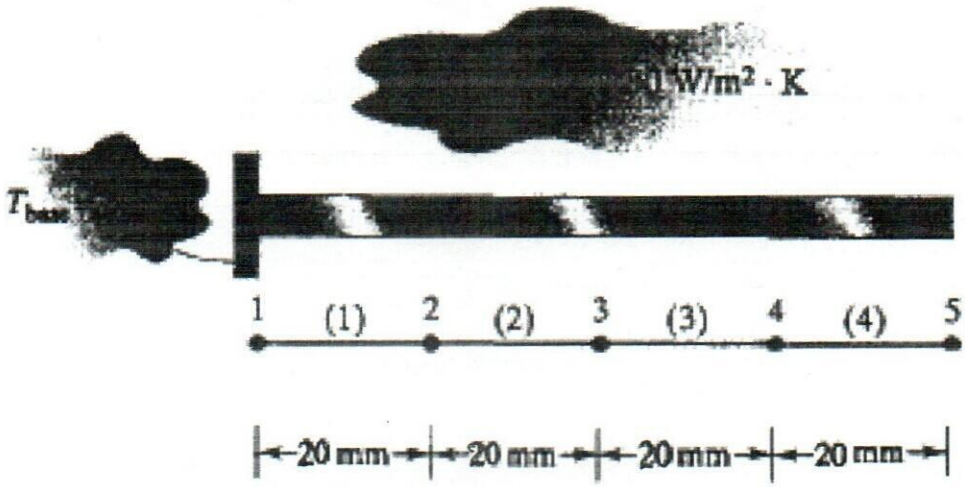


Figure Q6

Aluminum fins of a rectangular profile, shown in Figure Q6, are used to remove heat from a surface whose surface temperature is 100°C. The temperature of the ambient air is 20°C.

The thermal conductivity of Aluminum is 168 $W/m^2.K$ ($W/m^2.^0C$). The natural convective heat transfer coefficient associated with the surrounding air is $30W/m^2.^0C$). The fins are 80 mm long, 5 mm wide, and 1 mm thick.

(a) Determine the temperature distribution along the fin using the finite element model shown in the figure.

(b) Compute the heat loss per fin.

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Library.

00022

Faculty of Engineering & Technology
Bachelor of Science (Honours) in Engineering

CINEC CAMPUS
Beyond A Graduate

FE3311 INDUSTRIAL LAW

Semester-5 2025 (Batch –5)

Time allowed: 3 hours **02nd January 2025 from 1:30p.m. to 4:30p.m.**

Note:

- Attempt **all five (05) questions** and all carry equal marks.
- Write answers on A4 size booklet.
- Write your name and student number on each sheet.

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1)

a) "The Sri Lankan judicial system is hierarchical and does not afford a satisfactory system for dispute settlement". Comment **(06 marks)**

b) What do you mean by the term "Fundamental Rights"? Identify the Fundamental Rights under the Constitution of Sri Lanka with limitations, if any, in regard to each right. **(07 marks)**

c) Discuss the scope and application of the Personal laws and the General law of Sri Lanka **(07 marks)**

2) Choose any two (2) of the topics given below and explain the importance of each one to you as an ***engineer***.

I. Formation of a contract
II. Factors invalidating a contract
III. Breach of a contract and remedies for breach
IV. Discharge of a contract **(2*10=20 marks)**

3)

a) Mr. Bernard opened his house and garden to the public one day. All proceeds were to be donated to the local church restoration fund. A notice at the entrance read: "All visitors enter these promises at their own risk." Mr. Bernard's private quarters were not open to the public and notices were clearly placed on doors saying, "Private, closed to visitors." In the grounds were the ruins of an earlier house. A notice by these ruins read: This building is dangerous. Visitors are asked to keep their children under control."

Yohan visited the house, accompanied by his small son Shehan. While walking around the ruins, Shehan struggled free of Yohan's grasp and squeezed under a railing. He fell six feet to a lower level and suffered severe cuts and bruises and a broken arm. When Yohan saw that Shehan was injured, he ran for help into the main house and through a door marked "Private, closed to visitors". He was attacked by an Alsatian dog, which Mr. Bernard's Gardner Joseph had without Mr. Bernard's knowledge, been training as a guard dog. The dog caused Yohan severe injuries.

Advise Yohan and Shehan with special reference to occupiers Liabilities.

(12 marks)

b) "it's necessary to get prior approvals for the *Environmental Impact Assessment* report of a project". Comment. **(08 marks)**

4)

a) Sumanasiri went to a hardware shop belonging to Amarakoon and purchased a can of paint. His son Thevindu, a twenty-two years old boy used the paint and fell ill because of a toxic substance in the paint.

Discuss about the legal relief availability for Thevindu. **(10 marks)**

b) What are different types of tests that have been developed by the court to determine the employer-employee relationship? Explain briefly.

(10 marks)

5)

a) Identify at least 5 examples of relevant Sri Lankan legislation (Laws), that would directly affect the design, manufacture, and sale of your concept product. To be a valid answer, both the title and the year of enactment must be stated. **(10 marks)**

b) Kent & Joe is a private garment factory which undertook to provide a large consignment of winter clothing to shop in Germany. Due to a problem in obtaining raw materials in time, there was a delay in meeting the deadline and therefore they have no alternative but to employ their female workers in the night. The manager of the factory objects to this because he says that doing so is an offence under the law.

Assume that you are the Legal Advisor to the factory. What would be your advice to Kent & Joe to overcome this problem? **(10 marks)**