**CINEC CAMPUS**
*Beyond A Graduate*

# FACULTY OF ENGINEERING & TECHNOLOGY
## BACHELOR OF SCIENCE HONOURS IN ENGINEERING

## RESIT EXAMINATION

| | | |
|---|---|---|
| **Module Code** | : | **FE2311** |
| **Module Title** | : | **Engineering Mathematics III** |
| **Academic Year** | : | **2024/2025** |
| **Date** | : | **10th September 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 8 pages.
- Additional information is provided on pages 6,7 and 8.

## 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) Find the solution of $\frac{dy}{dx} - 2y = 3e^{5x}$ using the integrating factor, given that $y = 1$ when $x = 0$. [15 Marks]

ii) Find the general solution of the differential equation

$$\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 4y = 0.$$

[15 Marks]

iii) Find the solution of the differential equation

$$\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 3e^{4x}$$

given that $y = 1$ and $\frac{dy}{dx} = 1$ when $x = 0$. [40 Marks]

iv)

a) Find the domain and range of the function $f(x, y) = 2(x^2 + y^2)$ and then sketch the graph. [15 Marks]

b) Determine whether the limit, $\lim_{(x,y)\to(0,0)} \frac{5xy}{3x^2+2y^2}$ exists or not. [15 Marks]

2.

i) Find the $n^{\text{th}}$ derivative of $y = x^2e^{3x}$ using Leibnitz's theorem. [20 Marks]

ii) Find the power series solution of the differential equation

$$\frac{d^2y}{dx^2} + x\frac{dy}{dx} + 2y = 0,$$

using the Leibnitz–Maclaurin method, given the boundary conditions that $y = 1$ and $\frac{dy}{dx} = -1$ at $x = 0$. [40 Marks]

iii) Using the Euler-Cauchy method with step size $h = 0.2$, find $y(0.6)$ for the differential equation $\frac{dy}{dx} = x + y^2$, given that $y = 0.5$ when $x = 0$. [40 Marks]

3.

i) Find the Laplace transform of $f(t) = 2e^{3t} - 5$ by integration. $(\mathcal{L}\{f(t)\} = \int_0^{\infty} f(t)e^{-st}\,dt)$. [15 Marks]

ii) Find the inverse Laplace transform of $F(s) = \frac{3s+4}{s^2-5s+6} + \frac{s+1}{s^2-6s+25}$. [20 Marks]

iii) Solve the following initial-value problem using Laplace transforms: $y'' + 3y' + 2y = 2e^{-t}$ ; $y(0) = 1$ and $y'(0) = 1$.

[30 Marks]

iv) Find the general solution and sketch some of the trajectories in the phase plane for the following system of equation and determine the type of the critical point:

$$y_1' = 2y_1 + y_2$$
$$y_2' = 4y_1 - y_2$$

[35 Marks]

4.

i) A quality inspector is checking light bulbs from a factory. Each light bulb has a 0.2 probability of being defective (i.e., failing the inspection). Assume each inspection is independent.

a) Find the probability that the inspector finds the first non-defective bulb on the third inspection? [10 Marks]

b) What is the expected number of bulbs the inspector must check before finding the first non-defective bulb? [5 Marks]

c) Find the probability that the inspector needs to check 6 bulbs to find exactly 4 non-defective bulbs? [10 Marks]

ii) A website receives an average of 6 spam messages per day. Assume the number of spam messages per day follows a Poisson distribution.

a) Find the probability that no spam messages are received on a given day. [8 Marks]

b) Find the probability that at least 2 spam messages will be received over the next 2 days. [10 Marks]

c) How many days should be monitored so that the probability of receiving at least one spam message is 0.95? [9 Marks]

iii) A factory has 14 machines, of which 5 are new and 9 are old. A quality control team randomly selects 6 machines for inspection.

a) Find the probability that exactly 2 new machines are selected. [9 Marks]

b) Find the probability that at least 1 new machine is selected. [9 marks]

iv) A call center receives customer feedback that is categorized as Positive, Neutral, or Negative. Historical data shows that the probability of a feedback being rated positive, neutral, and negative are 0.5, 0.3, and 0.2, respectively. Suppose the center collects 20 feedback entries, and each is independent of the others.

a) Find the probability that exactly 16 are Positive, 2 are Neutral, and 2 are Negative. [15 Marks]

b) Given that 12 feedback entries are Positive, find the conditional probability that 5 entries are Negative. [15 Marks]

Table 1 Form of particular integral for different functions

| *Type* | *Straightforward cases* Try as particular integral: | *'Snag' cases* Try as particular integral: |
|---|---|---|
| (a) $f(x)=$ a constant | $v=k$ | $v=kx$ (used when C.F. contains a constant) |
| (b) $f(x)=$ polynomial (i.e. $f(x)=L+Mx+Nx^2+\cdots$ where any of the coefficients may be zero) | $v=a+bx+cx^2+\cdots$ | |
| (c) $f(x)=$ an exponential function (i.e. $f(x)=Ae^{ax}$) | $v=ke^{ax}$ | (i) $v=kxe^{ax}$ (used when $e^{ax}$ appears in the C.F.) (ii) $v=kx^2e^{ax}$ (used when $e^{ax}$ and $xe^{ax}$ both appear in the C.F.) |
| (d) $f(x)=$ a sine or cosine function (i.e. $f(x)=a\sin px+b\cos px$, where $a$ or $b$ may be zero) | $v=A\sin px+B\cos px$ | $v=x(A\sin px+B\cos px)$ (used when $\sin px$ and/or $\cos px$ appears in the C.F.) |
| (e) $f(x)=$ a sum e.g. (i) $f(x)=4x^2-3\sin 2x$ (ii) $f(x)=2-x+e^{3x}$ | (i) $v=ax^2+bx+c+d\sin 2x+e\cos 2x$ (ii) $v=ax+b+ce^{3x}$ | |
| (f) $f(x)=$ a product e.g. $f(x)=2e^x\cos 2x$ | $v=e^x(A\sin 2x+B\cos 2x)$ | |

## Leibnitz's theorem:

$$y^{(n)}=(uv)^{(n)}=u^{(n)}v+nu^{(n-1)}v^{(1)}+\frac{n(n-1)}{2!}u^{(n-2)}v^{(2)}+\frac{n(n-1)(n-2)}{3!}u^{(n-3)}v^{(3)}+\cdots$$

## Maclaurin's Series:

$$f(x)=f(0)+xf'(0)+\frac{x^2}{2!}f''(0)+\frac{x^3}{3!}f'''(0)+\cdots$$

## Formulae for Euler-Cauchy Method:

$$y_{p_1}=y_0+hy_0'$$

$$y_{c_1}=y_0+\frac{1}{2}h[y_0'+f(x_1,y_{p_1})]$$

## Laplace Transform:

$$F(s)=\mathcal{L}(f)=\int_0^{\infty}e^{-st}f(t)\,dt.$$

**Laplace Transform of Derivatives:**

$$\mathcal{L}(f') = s\mathcal{L}(f) - f(0)$$

$$\mathcal{L}(f'') = s^2\mathcal{L}(f) - sf(0) - f'(0).$$

$$\mathcal{L}(f^{(n)}) = s^n\mathcal{L}(f) - s^{n-1}f(0) - s^{n-2}f'(0) - \cdots - f^{(n-1)}(0).$$

**Some Functions $f(t)$ and Their Laplace Transforms $\mathcal{L}(f)$**

| | $f(t)$ | $\mathcal{L}(f)$ | | $f(t)$ | $\mathcal{L}(f)$ |
|---|---|---|---|---|---|
| 1 | 1 | $1/s$ | 7 | $\cos \omega t$ | $\dfrac{s}{s^2+\omega^2}$ |
| 2 | $t$ | $1/s^2$ | 8 | $\sin \omega t$ | $\dfrac{\omega}{s^2+\omega^2}$ |
| 3 | $t^2$ | $2!/s^3$ | 9 | $\cosh at$ | $\dfrac{s}{s^2-a^2}$ |
| 4 | $t^n$ $(n = 0, 1, \cdots)$ | $\dfrac{n!}{s^{n+1}}$ | 10 | $\sinh at$ | $\dfrac{a}{s^2-a^2}$ |
| 5 | $t^a$ ($a$ positive) | $\dfrac{\Gamma(a+1)}{s^{a+1}}$ | 11 | $e^{at}\cos \omega t$ | $\dfrac{s-a}{(s-a)^2+\omega^2}$ |
| 6 | $e^{at}$ | $\dfrac{1}{s-a}$ | 12 | $e^{at}\sin \omega t$ | $\dfrac{\omega}{(s-a)^2+\omega^2}$ |

**The Probability Mass Function of Hypergeometric Random Variable $X$:**

$$f(x) = \frac{\binom{K}{x}\binom{N-K}{n-x}}{\binom{N}{n}} \qquad x = \max\{0, n+K-N\} \text{ to } \min\{K, n\}$$

A set of $N$ objects contains
- $K$ objects classified as successes
- $N-K$ objects classified as failures

A sample of size $n$ objects is selected randomly (without replacement) from the $N$ objects where $K \le N$ and $n \le N$.

**The Probability Mass Function of Binomial Random Variable $X$:**

$$f(x) = \binom{n}{x} p^x (1-p)^{n-x}; \quad x = 0, 1, 2, \dots \qquad E(X) = np$$

**The Probability Mass Function of Poisson Random Variable $X$:**

$$f(x) = \frac{e^{-\lambda T}(\lambda T)^x}{x!} \; x = 0, 1, 2, \dots$$

**The Joint Probability Mass Function of Random Variables $X_1, X_2, \dots, X_k$ which have a Multinomial Distribution:**

$$P(X_1 = x_1, X_2 = x_2, \dots, X_k = x_k) = \frac{n!}{x_1! x_2! \dots x_k!} p_1^{x_1} p_2^{x_2} \dots p_k^{x_k}$$

for $x_1 + x_2 + \dots + x_k = n$ and $p_1 + p_2 + \dots + p_k = 1$.

**The Probability Mass Function of Negative Binomial Random Variable $X$:**

In a series of Bernoulli trials (independent trials with constant probability $p$ of a success), the random variable $X$ that equals the number of trials until $r$ successes occur is a **negative binomial random variable** with parameters $0 < p < 1$ and $r = 1, 2, 3, \dots$, and

$$f(x) = \binom{x-1}{r-1}(1-p)^{x-r} p^r \qquad x = r, r+1, r+2, \dots$$

**If X is a negative binomial random variable with parameters $p$ and $r$,**

$$\mu = E(X) = r/p \qquad \text{and} \qquad \sigma^2 = V(X) = r(1-p)/p^2$$

**The Probability Mass Function of Geometric Random Variable $X$:**

$$f(x) = (1-p)^{x-1} p \qquad x = 1, 2, \dots$$

**If X is a Geometric Random Variable with parameters $p$,**

$$\mu = E(X) = 1/p \qquad \text{and} \qquad \sigma^2 = V(X) = (1-p)/p^2$$

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

**FE3311 INDUSTRIAL LAW**

**Semester-5 2025 (Batch –5) Re-sit Examination**

**Time allowed: 3 hours 24th August 2025 from 09:00 a.m. to 12:00 noon**

**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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**01.**

a) Discuss the scope and application of the 'Kandyan (Sinhala) Law' in Sri Lanka. **(10 marks)**

b) Briefly discuss the hierarchy of courts and their limitations (powers). **(10 marks)**

**02.**

a) What are the legal requirements that should be fulfilled to make a valid offer? **(06 marks)**

b) Distinguish the terms *justa causa* and *consideration.* **(07 marks)**

c) Briefly explain the terms *dolus* and *culpa*. **(07 marks)**

**03.**

Sujith employed Nishshanka on a monthly salary to do the odd jobs as a carpenter's assistant on his building site. Sujith's neighbour Sirisoma wanted Nishshanka to work for him during the weekend for a period of two months, to attend to repairs on Sirisoma's roof. Sujith had instructed Nishshanka not to work outside his own work site. While working at Sirisoma's weekend, Nishshanka dropped plank (timber) carelessly, seriously injured Sirisoma's sister. Is it possible to get sue for the damage either from Sujith or Nishshanka? **(20 marks)**

**04.**

Gorge has established a small-scale sulphuric acid manufacturing plant on his own land. Kate a neighboured of Gorge who is running a tutory at her residents wants to take legal action against Gorge on the grounds that the noxious sulphur dioxide fumes emitted by the factory cause respiratory problems, headaches and faintness among her students and therefore she had to close the tutory.

Comment about the legal aspect in this regard. **(20 marks)**

**05.**

Write notes on followings.

a) Fixed term employment and Casual employment **(10 marks)**
b) Difference between a probationer and an apprentice **(10 marks)**