Faculty of Engineering (Shoubra)
Engineering Mathematics and Physics Department
Mid term exam

Benha University
Mechanical Department
2^{st} year Production
Time allowed: 1 hour

Student Name in Arabic: **Section:** **B.N.**

Choose <u>all</u> the correct answers

1) $\int_2^{\infty} e^{-x^2+4x-4}\,dx = \left(\frac{\pi}{2},\quad \Gamma(1/2),\quad \boxed{-\frac{\Gamma(-1/2)}{4}},\quad -\frac{\sqrt{\pi}}{2}\right)$

2) $\int_0^{\infty} \frac{x}{1+x^6}\,dx = \left(\beta(\frac{2}{3},\frac{1}{3}),\quad \sqrt{3}\pi\quad,\quad \boxed{\frac{\pi}{3\sqrt{3}}\ ,\qquad \frac{1}{6}\beta(\frac{2}{3},\frac{1}{3})}\right)$

3) $\int_0^{1} (1-x^2)^{b-1}\,dx = \left(\boxed{\frac{1}{2}\beta(\frac{1}{2},b)},\quad \frac{1}{2}\beta(1,2b)\,,\quad \boxed{\frac{\Gamma(3/2)\Gamma b}{\Gamma(\frac{1}{2}+b)}},\quad \frac{\Gamma(3/2)\Gamma b}{\sqrt{\pi}\Gamma(1+2b)}\right)$

4) $\int_0^{\infty} 3^{-4z^2}\,dz = \left(\sqrt{\frac{\pi}{\ln 3}}\,,\quad \boxed{\frac{\Gamma(3/2)}{2\sqrt{Ln3}}},\quad \frac{\sqrt{\pi}}{Ln3},\quad \frac{1}{2}\sqrt{\frac{\pi}{\ln 3}}\right)$

5) $L^{-1}\left\{\frac{1}{s^2(s^2+9)}\right\} = \left(\frac{\cos 3t - 1}{9},\quad \frac{1-\cos 3t}{9},\quad \boxed{\frac{3t - \sin 3t}{27}},\quad \int_{u=0}^{t} \frac{(\cos 3u - 1)}{9}\,du\right)$

6) $L\{(e^{-2t}\cos 3t)\,U(t-1)\} =$

$\left(\boxed{\int_1^{\infty} \cos 3t\, e^{-(s+2)t}\,dt},\ \frac{s+2}{(s+2)^2+9}\,e^{-s},\ \boxed{\left[\frac{(\cos 3)(s+2)-3\sin 3}{s^2+4s+13}\right]e^{-(s+2)}},\ \left[\frac{(\sin 3)(s+2)-3\cos 3}{s^2+4s+13}\right]e^{-(s+2)}\right)$

7) $\int_0^{\infty} \left(\frac{\cos t - \cos 3t}{t}\right) e^{-3t}\,dt = \left(Ln(\frac{9}{5}),\quad Ln\sqrt{(\frac{5}{9})}\,,\quad \boxed{Ln\sqrt{(\frac{9}{5})}},\quad Ln(\frac{5}{9})\right)$

8) By using Fourier expansion of the function $f(x) = |x|$, $-3 < x < 3$, then

$\sum_{m=1}^{\infty} \frac{1}{(2m-1)^2} = \left(\frac{\pi}{16},\quad \frac{16}{\pi^2},\quad \boxed{\frac{\pi^2}{8}},\quad \frac{8}{\pi^2}\right)$

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1) $\int_0^\infty (27)^{-8z^3} dz = \left(\frac{\Gamma(1/3)}{6\sqrt{3Ln3}}, \boxed{\frac{\Gamma(1/3)}{6\sqrt[3]{3Ln3}}}, \frac{\Gamma(2/3)}{6\sqrt[3]{3Ln3}}, \boxed{-\frac{\Gamma(-2/3)}{9\sqrt[3]{3Ln3}}} \right)$

2) $\int_{-2}^\infty e^{-x^2-4x} dx = \left(e^4\sqrt{\frac{\pi}{2}}, \quad e^{-4}\frac{\sqrt{\pi}}{2}, \quad \boxed{-e^4\frac{\Gamma(-1/2)}{4}}, \quad \boxed{e^4\Gamma(3/2)} \right)$

3) $\int_0^3 \frac{dx}{\sqrt{3x-x^2}} = \left(\Gamma(3/2)\beta(1,\frac{1}{2}), \boxed{2(\Gamma(3/2))^2\beta(1,\frac{1}{2}), \quad \beta(\frac{1}{2},\frac{1}{2}), -\beta(-\frac{1}{2},\frac{3}{2})} \right)$

4) $\int_0^\infty \frac{t^2\,dt}{1+t^4} = \left(\boxed{\frac{1}{4}\beta(\frac{1}{4},\frac{3}{4})}, \quad \frac{\pi}{\sqrt{2}}, \quad \beta(\frac{1}{4},\frac{3}{4}), \quad \boxed{\frac{\pi}{2\sqrt{2}}} \right)$

5) $\int_0^\infty t\cos 3t\, e^{-5t}\, dt = (-4/289, \quad \boxed{4/289}, \quad 15/578, \quad -15/578)$

6) $L\{t^2\, U(t-4)\} = \left(\frac{2}{s^3}e^{-4s}, \quad \int_0^\infty t^2 e^{-st}\, dt, \quad \boxed{\frac{2}{s^3}(8s^2+4s+1)e^{-4s}, \quad \int_4^\infty t^2 e^{-st}\, dt} \right)$

7) $L^{-1}\{\frac{1}{s^2(s+9)}\} = \left(\frac{e^{9t}-1}{9}, \quad \frac{1-e^{-9t}}{9}, \quad \boxed{\int_{u=0}^{t} \frac{1-e^{-9u}}{9} du}, \quad \int_{u=0}^{t} \frac{e^{9u}-1}{9} du \right)$

8) By using Fourier expansion of the function $f(x) = x^2$, $-\pi < x < \pi$, then

$\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n^2} = \left(\frac{\pi}{12}, \quad \frac{12}{\pi^2}, \quad \frac{\pi^2}{3}, \quad \boxed{\frac{\pi^2}{12}} \right)$

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1) $\int_0^\infty t^n e^{-mt} dt = \left(\frac{n!}{m^{n+1}}, \boxed{\frac{n\Gamma n}{m^{n+1}}}, \frac{\Gamma(n-1)}{m^{n+1}}, \frac{\Gamma(n+1)}{n^{m+1}} \right)$, n, m ∈ ℝ

2) $\int_0^2 t^3 \sqrt[3]{8-t^3}\,dt = \left(\frac{32}{3}\beta(\frac{2}{3},\frac{4}{3}), \beta(\frac{4}{3},\frac{4}{3}), \boxed{\frac{8\sqrt{3}}{15\pi}(\Gamma(1/3))^3, \frac{16}{15}\beta(\frac{1}{3},\frac{1}{3})} \right)$

3) $\int_0^1 x^3(\ln x)^4\,dx = \left(\frac{4!}{5^4}, \boxed{\frac{\Gamma(4)}{4^4}}, \frac{\Gamma(5)}{4^4}, \boxed{\frac{3}{128}} \right)$

4) $\int_0^\infty \frac{a\,dt}{\sqrt{t(a^2+t^2)}} = \left(\boxed{\frac{\pi}{\sqrt{2a}}, \frac{\beta(\frac{1}{4},\frac{3}{4})}{2\sqrt{a}}}, \beta(\frac{1}{4},\frac{3}{4}), \sqrt{\frac{2}{a}}\beta(\frac{1}{2},\frac{3}{2}) \right)$

5) L{sin3t U(t-2)} =

$\left(\frac{3}{s^2+9}e^{-2s}, \frac{1}{s^2+9}((\cos 6)s+3\sin 6)\,e^{-2s}, \boxed{\frac{1}{s^2+9}((\sin 6)s+3\cos 6)\,e^{-2s}, \int_2^\infty \sin 3t\, e^{-st}\,dt} \right)$

6) $\int_0^\infty t\sin 2t\, e^{-4t}\,dt = (0.03, 0.25, \boxed{0.04}, 0.4)$

7) By using Fourier expansion of the function $f(x) = x^2$, $-\pi < x < \pi$, then

$\sum_{n=1}^\infty \frac{1}{n^2} = \left(\frac{\pi}{6}, \frac{6}{\pi^2}, \pi^2, \boxed{\frac{\pi^2}{6}} \right)$

8) $L^{-1}\{\frac{1}{s^2(s-4)}\} = \left(\frac{e^{4t}-1}{4}, \frac{1-e^{-4t}}{4}, \int_{u=0}^t \frac{1-e^{-4u}}{4}du, \boxed{\int_{u=0}^t \frac{e^{4u}-1}{4}du} \right)$

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1) $\int_0^1 \frac{dx}{\sqrt{-\mathrm{Ln}\, x}} = (\boxed{\sqrt{\pi}},\quad -\sqrt{\pi},\quad \frac{\Gamma(-1/2)}{2},\quad \boxed{2\Gamma(3/2)})$

2) $\int_0^\infty t^m\, e^{-nt} dt = (\frac{m!}{n^{m+1}},\quad \boxed{\frac{m\Gamma m}{n^{m+1}}},\quad \frac{\Gamma(m-1)}{n^{m+1}},\quad \frac{\Gamma(m+1)}{m^{n+1}}),\ n, m \in \mathbb{R}$

3) $\int_0^2 \frac{t^2 dt}{\sqrt{2-t}} = (\beta(3,\frac{3}{2}),\quad 128/105,\quad 8\beta(3,\frac{3}{2}),\quad \frac{8}{7}\beta(3,\frac{1}{2}))$ Ans: $\frac{8}{\sqrt{2}}\beta(3,\frac{3}{2})$

4) By using Fourier expansion of the function $f(x) = \begin{cases} \pi/2 + x, & -\pi \le x \le 0 \\ \pi/2 - x, & 0 < x \le \pi \end{cases}$, then the sum $\frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \ldots = (\boxed{\frac{\pi^2}{8}},\quad \frac{\pi}{4},\quad \frac{8}{\pi^2},\quad \frac{\pi^2}{16})$

5) $\int_0^{\pi/2} \sqrt{\tan x}\, dx = (\beta(\frac{1}{4},\frac{3}{4}),\quad \boxed{\frac{\pi}{\sqrt{2}}},\quad \sqrt{2}\pi,\quad \boxed{\frac{1}{2}\beta(\frac{1}{4},\frac{3}{4})})$

6) $L^{-1}\{\frac{1}{s^2(s^2-9)}\} = (\frac{1+\cosh 3t}{9},\quad \frac{1-\cosh 3t}{9},\quad \frac{3t-\sinh 3t}{27},\quad \boxed{\int_{u=0}^{t} \frac{(\cosh 3u-1)}{9} du})$

7) $L\{(e^{3t}\sin 3t)\, U(t-2)\} =$

$(\int_1^\infty \sin 3t\, e^{-(s-3)t}\, dt,\quad \frac{3}{(s-3)^2+9}e^{-2s},\quad \boxed{[\frac{(\sin 6)(s-3)+3\cos 6}{s^2-6s+18}]e^{-2(s-3)}},\quad [\frac{(\cos 6)(s-3)+3\sin 6}{s^2-6s+18}]e^{-2(s-3)})$

8) $\int_0^\infty (\frac{e^{2t}-\cos 3t}{t})\, e^{-3t}\, dt = (\mathrm{Ln}(18),\quad \mathrm{Ln}(9),\quad \boxed{\frac{1}{2}\mathrm{Ln}(18)},\quad 2\,\mathrm{Ln}\sqrt{\frac{3}{2}})$

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3) $\int_{0}^{1} (1-x^2)^{b-1}\,dx = \left(\boxed{\frac{1}{2}\beta(\frac{1}{2},b)},\quad \frac{1}{2}\beta(1,2b),\quad \boxed{\frac{\Gamma(3/2)\Gamma b}{\Gamma(\frac{1}{2}+b)}},\quad \frac{\Gamma(3/2)\Gamma b}{\sqrt{\pi}\,\Gamma(1+2b)}\right)$

4) $\int_{0}^{\infty} (27)^{-8z^3}\,dz = \left(\frac{\Gamma(1/3)}{6\sqrt{3Ln3}},\quad \boxed{\frac{\Gamma(1/3)}{6\sqrt[3]{3Ln3}}},\quad \frac{\Gamma(2/3)}{6\sqrt[3]{3Ln3}},\quad \boxed{-\frac{\Gamma(-2/3)}{9\sqrt[3]{3Ln3}}}\right)$

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8) By using Fourier expansion of the function $f(x) = \begin{cases} \pi/2+x, & -\pi \le x \le 0 \\ \pi/2-x, & 0 < x \le \pi \end{cases}$, then the sum $\frac{1}{3^2}+\frac{1}{5^2}+\frac{1}{7^2}+.... = \left(\boxed{\frac{\pi^2}{8}},\quad \frac{\pi}{4},\quad \frac{8}{\pi^2},\quad \frac{\pi^2}{16}\right)$

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2) $\int_{-2}^\infty e^{-x^2-4x}\, dx = \left(e^4\sqrt{\frac{\pi}{2}},\quad e^{-4}\frac{\sqrt{\pi}}{2},\quad \boxed{-e^4\frac{\Gamma(-1/2)}{4},\quad e^4\Gamma(3/2)}\right)$

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2) $\int_0^2 t^3\sqrt[3]{8-t^3}dt = \left(\frac{32}{3}\beta(\frac{2}{3},\frac{4}{3}),\quad \beta(\frac{4}{3},\frac{4}{3}),\quad \boxed{\frac{8\sqrt{3}}{15\pi}(\Gamma(1/3))^3,\ \frac{16}{15}\beta(\frac{1}{3},\frac{1}{3})}\right)$

3) $\int_0^1 \frac{dx}{\sqrt{-\operatorname{Ln} x}} = \left(\boxed{\sqrt{\pi}},\quad -\sqrt{\pi},\quad \frac{\Gamma(-1/2)}{2},\quad \boxed{2\,\Gamma(3/2)}\right)$

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3) $\int_0^2 \frac{t^2\,dt}{\sqrt{2-t}} = \left(\beta(3,\frac{3}{2}),\ 128/105,\ 8\beta(3,\frac{3}{2}),\ \frac{8}{7}\beta(3,\frac{1}{2})\right)$ Ans: $\frac{8}{\sqrt{2}}\beta(3,\frac{3}{2})$

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