Q1(1):

By tesing the potential rational roots $\pm 1, \pm 2$ given by the rational root theorem,

we have $x = 1$ is a root.

Then, we can do the factorisation by the long division:

$$x^3 - 2x^2 - x + 2 = 0$$

$$(x-1)(x^2 - x - 2) = 0$$

$$(x-1)(x+1)(x-2) = 0$$

$$x = \boxed{\pm 1, 2}$$

Q1(2):

$$\cos x - 2\cos^2 x = 0$$

$$\cos x(2\cos x - 1) = 0$$

$$\cos x = 0, \frac{1}{2}$$

$$x = \boxed{\frac{\pi}{3}, \frac{\pi}{2}}$$

Q1(3):

$|\sqrt{8} - 3| + |2 - \sqrt{2}|$

$= 3 - \sqrt{8} + 2 - \sqrt{2}$

$= 3 - 2\sqrt{2} + 2 - \sqrt{2}$

$= \boxed{5 - 3\sqrt{2}}$

Q1(4):

$$\log_2(x-1) = \log_4(x-1)$$

$$(x-1)^2 = x-1$$

$$x - 1 = 1 \text{ } (x \neq 1 \text{ as } x > 1 \text{ for the logarithms to be defined})$$

$$x = \boxed{2}$$

Q1(5):

$f(x) = \cos x + \frac{1}{2}\cos x - \frac{\sqrt{3}}{2}\sin x$

$= \sqrt{3}(\frac{\sqrt{3}}{2}\cos x - \frac{1}{2}\sin x)$

$= \sqrt{3}(\sin\frac{\pi}{3}\cos x - \cos\frac{\pi}{3}\sin x)$

$= -\sqrt{3}\sin(x - \frac{\pi}{3})$.

Therefore, $m = \boxed{\sqrt{3}}$ and it takes when $x - \frac{\pi}{3} = \frac{3\pi}{2}$, i.e. $x = \boxed{\dfrac{11\pi}{6}}$.

Alternative $f'(x) = -\frac{3}{2}\sin x - \frac{\sqrt{3}}{2}\cos x$.

To find the extremum, we set $f'(x) = 0$, then $x = \frac{5\pi}{6}, \frac{11\pi}{6}$.

$f''(x) = -\frac{3}{2}\cos x + \frac{\sqrt{3}}{2}\sin x$.

As $f''(\frac{11\pi}{6}) < 0$, $f(x)$ takes the maximum when $x = \boxed{\dfrac{11\pi}{6}}$ and the value $m = f(\frac{11\pi}{6}) = \boxed{\sqrt{3}}$.

Q1(6):

$\lim_{h\to 0}(1+2h)^{\frac{1}{h}}$

$= \lim_{t\to 0}(1+t)^{\frac{2}{t}}$

$= \boxed{e^2}$

Q1(7):

Solving:

$$\begin{cases} 2(x-1) = 6(y-1)......(1) \\ 3(x-1) = 6(z-2)......(2) \\ x+2y-4z+1 = 0......(3) \end{cases}$$

By $2 \times (2) - 3 \times (1)$, we have $12(z-2) - 18(y-1) = 0$, i.e. $z = \frac{3}{2}y + \frac{1}{2}$.

Substitute it into (3), we have $(3y-2) + 2y - 4(\frac{3}{2}y + \frac{1}{2}) + 1 = 0$, i.e. $y = \boxed{-3}$.

Subtituting back, we have $x = \boxed{-11}$ and $z = \boxed{-4}$.

Q1(8):

$\frac{dy}{dx} = \frac{1}{x}$.

Let the point of tangency be $(p, \ln p)$, then the equation of the tangent is $y -$

$\ln p = \frac{1}{p}(x-p)$.

As it passes through (0,0), we have $-\ln p = \frac{1}{p}(-p)$, i.e. $p = e$.

Therefore, the equation is $y - 1 = \frac{1}{e}(x-e)$, i.e. $y = \boxed{\frac{1}{e}x}$.

Q1(9):

$\sum\limits_{n=1}^{\infty} \frac{1}{n(n+2)}$

$= \sum\limits_{n=1}^{\infty} (\frac{1}{2n} - \frac{1}{2(n+2)})$

$= \frac{1}{2} + \frac{1}{4}$

$= \boxed{\frac{3}{4}}$

Q1(10):

$\lim\limits_{x\to-\infty} \frac{2x+1}{\sqrt{x^2+1}}$

$= \lim\limits_{x\to-\infty} \frac{2+\frac{1}{x}}{-\sqrt{1+\frac{1}{x^2}}}$

$= \boxed{-2}$

Note: As x takes negative value, it did not be put inside the square root directly.

Instead, its absolute value be put inside. Therefore, a negative sign is added.

Q1(11):

$f(x) = \ln \frac{\sqrt{x-1}}{x+1} = \frac{1}{2}\ln(x-1) - \ln(x+1)$

$f'(x) = \boxed{\frac{1}{2(x-1)} - \frac{1}{x+1}}$

Q1(12):

Note that the function inside the integral is an odd function. Therefore, the integral is valued $\boxed{0}$.

Q2:

1): $A^n = \boxed{\begin{bmatrix} (\frac{1}{2})^n & 0 \\ 0 & (\frac{1}{2})^n \end{bmatrix}}$.

2): $S = \sum\limits_{k=1}^{n} A^k$

$= \begin{bmatrix} \sum\limits_{k=1}^{n} (\frac{1}{2})^k & 0 \\ 0 & \sum\limits_{k=1}^{n} (\frac{1}{2})^k \end{bmatrix}$

$= \begin{bmatrix} \frac{(\frac{1}{2})^{n+1} - \frac{1}{2}}{\frac{1}{2} - 1} & 0 \\ 0 & \frac{(\frac{1}{2})^{n+1} - \frac{1}{2}}{\frac{1}{2} - 1} \end{bmatrix}$

$= \boxed{\begin{bmatrix} 1 - (\frac{1}{2})^n & 0 \\ 0 & 1 - (\frac{1}{2})^n \end{bmatrix}}$

3): As det(S)$=\frac{1}{(1-(\frac{1}{2})^n)^2}$, $S^{-1} = \boxed{\begin{bmatrix} \frac{1}{1-(\frac{1}{2})^n} & 0 \\ 0 & \frac{1}{1-(\frac{1}{2})^n} \end{bmatrix}}$

Q3:

1): $\int_0^{\frac{\pi}{2}} \sin^3 x dx$

$= -\int_0^{\frac{\pi}{2}} (1 - \cos^2 x) d(\cos x)$

$= -[\cos x - \frac{1}{3}\cos^3 x]_0^{\frac{\pi}{2}}$

$= \boxed{\dfrac{2}{3}}$

2): $I_{2k+1} \cdot I_{2k} = \frac{\pi}{2} \cdot \boxed{\dfrac{1}{2k+1}}$ by the telescoping property.

3): Similarly, $b_k = \boxed{\dfrac{1}{2k}}$.

4): $L = \lim\limits_{k\to\infty} \frac{1}{k}(\frac{(2k)(2k-2)\dots 4\cdot 2}{(2k-1)(2k-3)\dots 3\cdot 1})^2 = \lim\limits_{k\to\infty} \frac{2k+1}{k}(\frac{\frac{\pi}{2}\cdot I_{2k+1}}{I_{2k}})$.

As $I_{2k+1} < I_{2k} < I_{2k-1}$, $\lim\limits_{k\to\infty} \frac{2k+1}{k}(\frac{\frac{\pi}{2}\cdot I_{2k+1}}{I_{2k-1}}) < L < \lim\limits_{k\to\infty} \frac{2k+1}{k}(\frac{\frac{\pi}{2}\cdot I_{2k+1}}{I_{2k+1}})$.

Moreover, $\lim\limits_{k\to\infty} \frac{2k+1}{k}(\frac{\frac{\pi}{2}\cdot I_{2k+1}}{I_{2k-1}}) = \frac{\pi}{2} \cdot \lim\limits_{k\to\infty} \frac{2k+1}{k}(\frac{2k}{2k+1}) = \pi$.

$\lim\limits_{k\to\infty} \frac{2k+1}{k}(\frac{\frac{\pi}{2}\cdot I_{2k+1}}{I_{2k+1}}) = \frac{\pi}{2} \cdot \lim\limits_{k\to\infty} \frac{2k+1}{k} = \pi$.

By squeeze theorem, $L = \boxed{\pi}$.