Q3)
For upper bound observe that dot product of 2 unit vectors can be almost 1 by Cauchy Schwartz inequality $(\sum a_i^2)(\sum b_i^2) \geq (\sum a_i b_i)^2$.
$\phi^i \ and \ \psi_j \ are \ both \ unit \ vectors, \ hence \ |\phi^i * \psi_j| \leq 1 \ for \ any \ i, j$, hence $max(|\phi^i * \psi_j|) \leq 1$ and $\mu(\phi, \psi) \leq \sqrt{n}$.
For lower bound , take $g_i = \phi^i$ and express it as linear combination of columns of ψ and take transpose , since all rows of ϕ are normalised to unit magnitude . Hence we expressed a row of ϕ as linear combination of columns of ψ and then took transpose. So g_i is a row vector now.
Let $g_i^t = \sum_{k=1}^{n} a_k \psi_k$. Since g_i is unit normal $g_i \,.\, g_i^t = 1$ and hence $\sum_{k=1}^{n} a_k^2 = 1$.
ψ is an orthonormal matrix and hence $\psi_i \,.\, \psi_j$ = 1 for (i=j) and 0 otherwise so
$|g_i \,.\, \psi_j| = |a_j|$ as only $a_j(\psi_j^t \,.\, \psi_j)$ is the non zero term in the dot product.
So $\mu(g_i, \psi) = \sqrt{n} \max_{j \in (0,1,...n-1)} |a_j|$. The denominator term in the original formula for coherence is onc since $\sum_{k=1}^{n} a_k^2 = 1$.

$\sum_{k=1}^{n} |a_k|^2 = 1$, hence the min value of $S = \max_{j \in (0,1,...n-1)} |a_j|$ can be $\frac{1}{\sqrt{n}}$ since if the min value is < $\frac{1}{\sqrt{n}}$, then for all j , $|a_j| < \frac{1}{\sqrt{n}}$, this implies $|a_j|^2 < \frac{1}{n}$ and $\sum_{k=1}^{n} a_k^2 < n * \frac{1}{n} = 1.$
Hence we get $\sum_{k=1}^{n} a_k^2 < 1$ which is a contradiction to $\sum_{k=1}^{n} a_k^2 = 1.$

Whereas the min value of $\frac{1}{\sqrt{n}}$ can be achieved by setting $|a_j| = \frac{1}{\sqrt{n}}$ for all j. Then $\sum_{k=1}^{n} a_k^2 = 1$ also and $S = \max_{j \in (0,1,...n-1)} |a_j|$ = $\frac{1}{\sqrt{n}}$ also .
Hence the minimal value of coherence is obtained when $g_i^t = \frac{1}{\sqrt{n}} \sum_{k=1}^{n} \psi_k$ and
$min \ \mu(g_i, \psi) = \sqrt{n} * S = \sqrt{n} * \frac{1}{\sqrt{n}} = 1$
So $\mu(g_i, \psi) \geq 1$

Now $\mu(\phi, \psi) = \max_{i \in (0,1,...n-1)} \mu(g_i, \psi)$ where we represented $g_i = \phi^i$ and all rows of ϕ can be independently chosen.
$\mu(g_i, \psi) \geq 1$ for all i, hence $\mu(\phi, \psi) \geq 1$ and we showed that $\mu(g_i, \psi) = 1$ is possible when $g_i^t = \frac{1}{\sqrt{n}} \sum_{k=1}^{n} \psi_k$. Hence for all i, choose $g_i^t = \frac{1}{\sqrt{n}} \sum_{k=1}^{n} \psi_k$, then each $\mu(g_i, \psi) = 1$ and hence the minimum value of $\mu(\phi, \psi) = \max_{i \in (0,1,...n-1)} \mu(g_i, \psi) = 1.$

Thus the value of coherence $\mu(\phi, \psi)$ must lie in the range $[1, \sqrt{n}]$.