- Which of the following medical imaging types has scattering configuration, uses radio frequency and is non-ionizing, anatomical, three-dimensional imaging?

  a) SPECT　　b) Computed tomography　　c) Magnetic resonance
  d) Ultrasound　　e) Fluorescence

- Which of the following statements is **correct,** which is **incorrect**?

  - The contrast in MRI is limited in soft tissue, whereas it is quite versatile and valuable for imaging the head, lungs, abdomen, pelvis, and extremities. …………
  - LSF is linear integral of PSF. ……………
  - Computed tomography is more expensive than MRI due to need for the computerization of the mathematical method - Fourier transform. …………
  - MRI involves ionizing radiation, so that it is not completely noninvasive imaging technique. ……………..
  - In PET detector and source are surrounding a patient and rotating around a patient. ……………..
  - Computed tomography is the first imaging modality that was designed to measure function within the body rather than structure. ……………..
  - Artifacts are random fluctuations in image intensity. ……………..
  - Noise is reproducible scan after scan. ………………
  - Distribution of photons per unit area in x-ray image intensifier is modeled by Gaussian random variable. ………………
  - Aliasing is an example of noise. …………………
  - Chest X-ray, fluoroscopy, mammography, mobile X-ray systems are examples of PR. ……………

- Which of the following “medical imaging modality – physical signal” matching is **correct,** which is **incorrect**?

  - precession of spin systems – ultrasound ………..
  - total internal reflection of light – laparoscopy ………….
  - scattering of radio-frequency wave – ultrasound ………….
  - emission of gamma rays from radiotracers in the body – PR ………….

- Which of the following “medical imaging modality – working principle” matching is **correct**?

  - SPECT – generated two gamma rays move exactly in opposite directions and if not scattered they reach the gamma detector at the same time ………..
  - Computed tomography – employs reflection/scattering configuration of X-rays taken at different angles ……….

- Explain why ultrasound imaging systems are widespread and in common usage.

- Determine whether the system *g(x,y)=xyf(x,y)* is (1) linear and/or (2) shift-invariant.

- Find the transfer function of PSF given as $h(x)=e^{-x^2/30}$. Then determine the MTF of the system and sketch it roughly. On the sketch indicate the region which is responsible for the resolution of the system, explain it.

Basic Fourier transform pairs

Signal	Fourier Transform
1	$\delta(u,v)$
$\delta(x,y)$	1
$\delta(x-x_0, y-y_0)$	$e^{-j2\pi(ux_0+vy_0)}$
$\delta_s(x,y;\Delta x,\Delta y)$	$\mathrm{comb}(u\Delta x, v\Delta y)$
$e^{j2\pi(u_0x+v_0y)}$	$\delta(u-u_0, v-v_0)$
$\sin[2\pi(u_0x+v_0y)]$	$\frac{1}{2j}[\delta(u-u_0,v-v_0)-\delta(u+u_0,v+v_0)]$
$\cos[2\pi(u_0x+v_0y)]$	$\frac{1}{2}[\delta(u-u_0,v-v_0)+\delta(u+u_0,v+v_0)]$
$\mathrm{rect}(x,y)$	$\mathrm{sinc}(u,v)$
$\mathrm{sinc}(x,y)$	$\mathrm{rect}(u,v)$
$\mathrm{comb}(x,y)$	$\mathrm{comb}(u,v)$
$e^{-\pi(x^2+y^2)}$	$e^{-\pi(u^2+v^2)}$

$$F(u,v)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y)e^{-j2\pi(ux+vy)}\,dx\,dy$$

$$f(x,y)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} F(u,v)e^{j2\pi(ux+vy)}\,du\,dv$$

Properties of the Fourier transform

Property	Signal	Fourier Transform
	$f(x,y)$	$F(u,v)$
	$g(x,y)$	$G(u,v)$
Linearity	$a_1f(x,y)+a_2g(x,y)$	$a_1F(u,v)+a_2G(u,v)$
Translation	$f(x-x_0,y-y_0)$	$F(u,v)e^{-j2\pi(ux_0+vy_0)}$
Conjugation	$f^*(x,y)$	$F^*(-u,-v)$
Conjugate symmetry	$f(x,y)$ is real-valued	$F(u,v)=F^*(-u,-v)$ $F_R(u,v)=F_R(-u,-v)$ $F_I(u,v)=-F_I(-u,-v)$ $\lvert F(u,v)\rvert=\lvert F(-u,-v)\rvert$ $\angle F(u,v)=-\angle F(-u,-v)$
Signal reversing	$f(-x,-y)$	$F(-u,-v)$
Scaling	$f(ax,by)$	$\frac{1}{\lvert ab\rvert}F\left(\frac{u}{a},\frac{v}{b}\right)$
Rotation	$f(x\cos\theta-y\sin\theta, x\sin\theta+y\cos\theta)$	$F(u\cos\theta-v\sin\theta, u\sin\theta+v\cos\theta)$
Circular symmetry	$f(x,y)$ is circularly symmetric	$F(u,v)$ is circularly symmetric $\lvert F(u,v)\rvert=F(u,v)$ $\angle F(u,v)=0$
Convolution	$f(x,y)*g(x,y)$	$F(u,v)G(u,v)$
Product	$f(x,y)g(x,y)$	$F(u,v)*G(u,v)$
Separable product	$f(x)g(y)$	$F(u)G(v)$
Parseval's theorem	$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\lvert f(x,y)\rvert^2\,dx\,dy=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\lvert F(u,v)\rvert^2\,du\,dv.$	

$$\boxed{g(x,y)=h(x,y)*f(x,y)}=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(\xi,\eta)h(x-\xi,y-\eta)\,d\xi\,d\eta$$

$$\int_{-\infty}^{\infty} e^{-a^2\tau^2}\,d\tau=\frac{\sqrt{\pi}}{a},\quad \text{for } a\neq 0$$